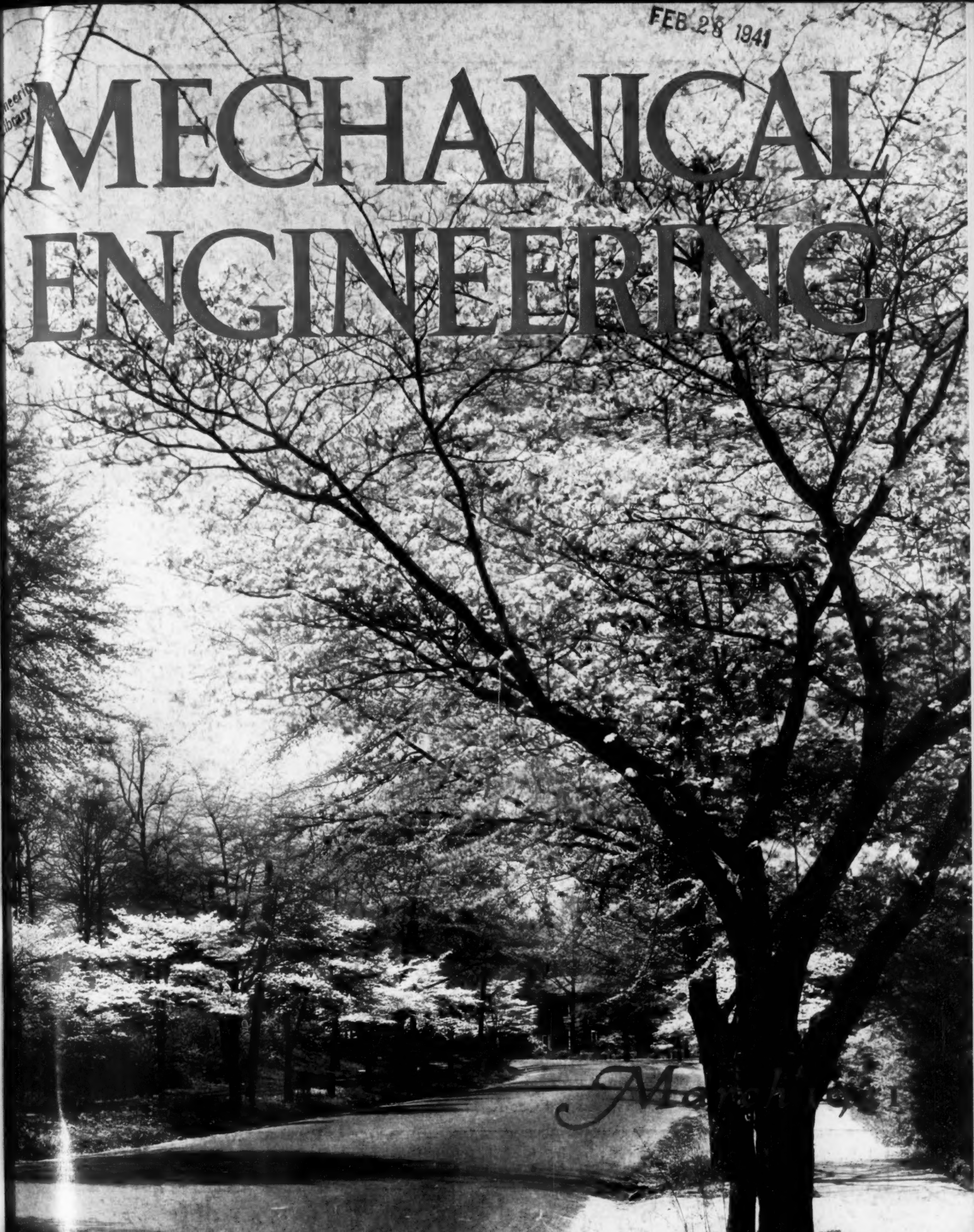
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Engineers and Machines Against Time—Cylinder Barrels in Production at Wright Aeronautical Corporation

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MECHANICAL ENGINEERING

MARCH
1941

GEORGE A. STETSON, *Editor*

Task for Engineers

SPEAKING at a Newcomen dinner in New York on February 13, the Right Reverend Frank W. Sterrett, the Bishop of Bethlehem, American chaplain of The Newcomen Society of England, concluded his address with these words:

> I personally see in the not distant future as essential to a healthy civilization some kind of federation of free world states, independent, vigorous, yet working together under just law adequately enforced and sacrificing only the degree of sovereignty necessary to maintenance of the common good. But to bring to pass such a dominance in our world of men of good will we shall need the engineer with his deserved reputation for practical common sense and his testimony that the plan is workable. It will be a big construction problem, perhaps the most difficult so far undertaken, but we believe it can be done.
>
> Many a battle has been lost because men lacked confidence in the outcome. That has not been characteristic of the engineer. He is accustomed to face hard tasks demanding his best. The rebuilding and the restoring of an ordered world present such a problem. Some of us will have a part in it; but we all can help by keeping clearly before us an understanding of a worthwhile purpose and faith in its conclusion. In such a view, it seems to me there is a continuing place of dignity for the engineer of tomorrow.

In these words Bishop Sterrett voiced a faith in the engineer and his ability that is being expressed more and more commonly in recent years. Whether such faith is justified, the engineer will have to examine his heart and his works to discover. But certain it is that the opportunity for service exists and the responsibility for meeting it is a challenge.

Engineers Have a Method

WHY is faith in the engineer being voiced by an increasing number of earnest men? The answer lies in the fact that faith in the engineer has been demonstrated in the past by his works. Systems of government have failed; political, social, and economic nostrums have been shown to be false or imperfect; creeds have collapsed. Faith is destroyed because the substance of faith is found to be hollow. But the faith of the engineer is in truth. The failure of a supposed truth does not destroy the engineer's faith in truth itself, even if a particular facet of truth is unseen or obscure. The great triumph of science and engineering has been this substitution of fundamental truth itself, with all that acceptance of truth implies, for dogma, either privately held or imposed by authority.

In addition to their faith, engineers share with scientists a method of searching for truth where it may be found. This involves a patient objective assembly of facts, the exercise of controls to avoid false conclusions, and a building up of the facts thus ascertained into a body of knowledge which organized human effort can apply to what are believed to be useful ends. Where extension of the method is most needed is in the minds of common people to the end that their social, economic, and political relationships and organizations may be as intelligently planned, constructed, and operated as are the technological and scientific triumphs of a physical nature. Engineers can assist in the popularization of their method.

In his broadcast of February 9, Winston Churchill directed attention once more to the fact that the war in Europe was a contest of machines—the navy, the air-force, the tank corps. Behind these machines are the vast organizations of men who plan, produce, and maintain them, the realm in which the engineer is so strategically placed. In this realm the engineer had his origin. So closely identified with it was he that the term "civil engineer" was used to designate the man engaged in peacetime, rather than wartime, pursuits. For several generations, fortunately, the engineer's greatest work has been directed to the ends of peaceful civil life, and not the ends of war. And now that a considerable portion of the engineering talent of the world is engaged in war and defense activities, hope arises in the minds of men that the engineer will be prepared and competent to take on enlarged duties in the years of economic, social, and political turbulence that are likely to follow the present war. In the conversion of this hope into a reality, Bishop Sterrett and other thoughtful men are putting their faith in the engineer. The engineer must not fail.

Plans for Action

FORTUNATE it is for the world that there are men of influence and vigor who experienced the World War and the depression which followed. For them, both were realities. For many of them the lessons of three decades have not been lost. Thus W. L. Batt, at present engaged in the Office of Production Management, in an address before the A.S.M.E. last December, called for the creation of "a small group of the ablest men in the country," who could be "set off in a corner by themselves, instructed to forget all about the immediate problems of procuring war material, except as it affects future national economy," and who should "set to work now on an industrial demobilization plan." Mr. Batt's address,

which was published under the title "Through a Glass, Darkly," in the January issue of MECHANICAL ENGINEERING, has struck a sympathetic chord in the minds of engineers and is leading them to re-examine their duties as engineers and citizens in the extension of their functions into the field of economic control that the suggested industrial demobilization plan calls for.

What Mr. Batt put into simple words as a call for intelligent planning is engaging the minds of scientists, economists, engineers, and laymen. On page 216 of this issue will be found a brief abstract of an analysis of the situation created by the war issued by The Brookings Institution under the authorship of an eminent economist, Harold G. Moulton. An equally eminent industrialist, Charles E. Wilson, president of the General Electric Company, provided a "blueprint" for industry in an address at the recent Winter Convention of the American Institute of Electrical Engineers. Mr. Wilson divided the future course of economic events into overlapping periods whose approach would be heralded by certain values of the Federal Reserve Board's index of production, unadjusted, and laid out appropriate steps to take.

Regardless of how universally Mr. Wilson's blueprint is accepted, it is heartening to discover that a man of his position has carried his thinking realistically into the troubled area of the immediate future. It is significant also that both Mr. Batt and Mr. Wilson delivered their addresses before engineering societies. It marks engineering societies as fertile ground for the seeds of reconstruction which must be planted now if the harvest of an effective demobilization plan is to be ready when the unpredictable hour of the ending of hostilities finally strikes. By such evidence as this the faith of the world in the engineer is being justified bit by bit.

"For the benefit of mankind" was the objective that Tredgold set for the services of engineers in his famous definition. For generations it was the physical forces of nature directed toward the construction and production of physical things that concerned the engineer. The world needed them. But in providing them the engineer mastered the technique of production of energy, materials, and goods. Doing this he found a wide field for his services, greater satisfaction, and larger remuneration because he handled men. Young as this technique is, to its development the engineer brings to bear his effective objective method, based on the harmony of ultimate truth. The world needs this technique desperately today. If the engineer can convince his fellows to adopt his method in the field of human relationships, the high hopes of Bishop Sterrett will be on the road to realization.

Admiral Cone

ON February 12, at Orlando, Fla., Admiral Hutchinson I. Cone, honorary member A.S.M.E., and member since 1910, died of a heart ailment at the age of 69. Retired in 1922, Admiral Cone supplemented his active career in the Navy with various assignments in official and industrial life for which his naval career had laid the foundation. At the time of his death he was serving as chairman of the board of Moore and McCormack Co., Inc.

Admiral Cone first attracted general notice as fleet engineer when the whole Navy went around the world in 1908-1909, during Theodore Roosevelt's administration. This bold venture was a success because Cone had so organized the continuous inspection and maintenance of machinery and power plants afloat that the fleet functioned perfectly at great distances from navy yards and repair bases. He was given full credit for this engineering feat that made the modern steam Navy "as seagoing as the old sailing frigates."

His achievement led, on May 2, 1909, to his appointment by the President as engineer in chief and chief of the Bureau of Steam Engineering with the rank of rear admiral although only a lieutenant commander. At the age of 38 he was the youngest man ever to be selected for this highly important task or responsibility as head of any naval bureau. As engineer in chief, he consolidated the scheme of fleet maintenance, influenced design and construction of machinery to support it, and established a fixed engineering policy which is followed today. During his period of service two outstanding developments began, namely, the change from coal burning to oil burning in naval vessels and investigations which led to the adoption of electric drive for naval vessels. The Bureau of Steam Engineering under his guidance kept to the forefront in engineering progress, particularly along electrical lines and the development of efficient propellers.

During the war Cone was called by Admiral Sims to take command of all U. S. Naval Aviation Forces in Europe. By sound engineering planning and administration Cone brought these forces to an excellent standard of equipment and training for the performance of extremely useful service.

Cone retired from the Navy in 1922 with the rank of rear admiral and after a short period with the Panama Railroad Steamship Line in 1924 and 1925 served as vice-president and general manager of the U. S. Shipping Board Emergency Fleet Corporation.

In 1926 and 1927, Admiral Cone served as vice-president and treasurer of the Daniel Guggenheim Fund for Promotion of Aeronautics. In this capacity, he directed the disbursement of $5,000,000 with excellent results in the advancement of aeronautic science and in improved public understanding of the possibilities of aviation in commercial transport.

In 1928, he returned to the Shipping Board as commissioner, resigning in March, 1935. He proposed a program of engineering development and secured appropriations therefor from Congress. This led to a series of investigations of new and improved methods of shipbuilding and propulsion. Model-basin experiments included propeller research and studies of hull forms. Tests of ships for comparison with model performance were made. Experiments into the possibilities of increasing speed and efficiency of existing ships were conducted. The data secured in these tests were made available so that Admiral Taylor's "Speed and Power of Ships" could be brought up to date and published.

PROGRESSIVE ASSEMBLY OF AIRCRAFT ENGINES

NEW PRODUCTION LINES *for* AIRCRAFT ENGINES

By R. F. GAGG

WRIGHT AERONAUTICAL CORPORATION, PATERSON, N. J.

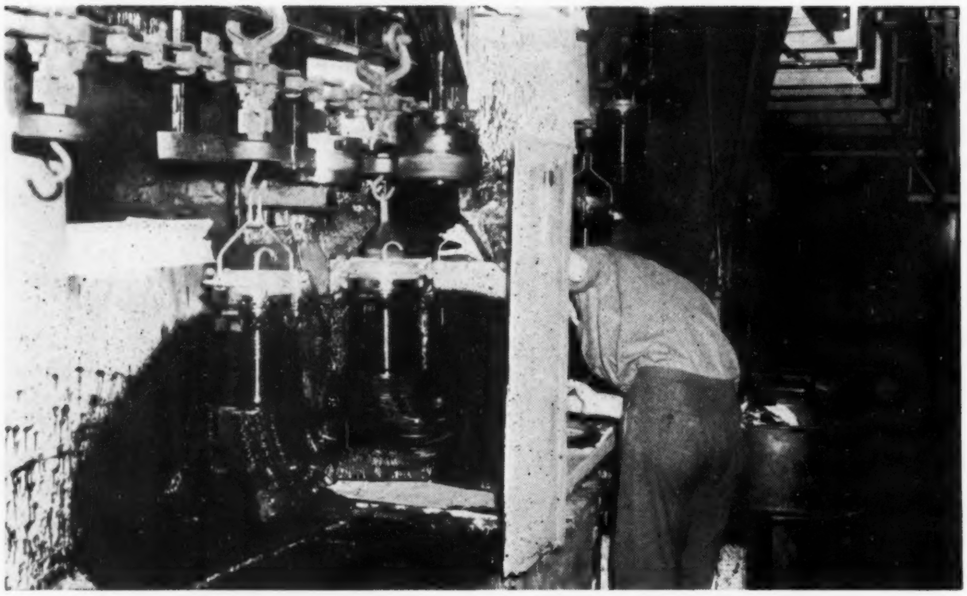
RAPID acceleration in the growth of the aircraft-manufacturing industry resulting from the national-defense program has presented at one time a series of new manufacturing problems such as would ordinarily be encountered in the course of more normal industrial growth over a period of several years. Fortunately, the production men in this industry are prepared for the necessary changes in process required by the expanded production program. They have always adopted every new manufacturing development which promised improvement in the quality of their product. This constant seeking for higher quality has kept them in close contact with the machine-tool builders, and therefore abreast of new developments in the principal manufacturing industries.

The most urgent of our current problems is the requirement for the feasible maximum of production. When all demands for production are counted, engine output appears to be limited principally by the capacity of management and trained personnel to take the punishment imposed by the program. When plans now under way are completed, the combined output of the American aircraft-engine industry, as reported in the press, will approximate 15 times its capacity as of the summer of 1939.

The basic problem of increasing production is presented with a corollary demand that there shall be no sacrifice in the technical performance and durability of the product. Less than a year ago it was a popular notion that most of the fussy requirements for fine workmanship in the aircraft engine could be discarded in any program calling for really high production. It is now more generally realized that even aircraft destined only for wartime combat service must be dependable in the highest practicable degree. Frequent need for repair under conditions where repairs are virtually impossible has amply demonstrated that the most useful airplane is the one which can be depended upon to perform its mission repeatedly under difficult operating conditions far from adequate service facilities. Reports from both sides of the current combat show that military aircraft frequently run through several overhaul periods before being lost in action. Only those items of "quality" which have an effect primarily on appearance of the product rather than upon its durability should be sacrificed to speed production. It was also popularly supposed that reductions in technical performance would be permissible in wartime, but experience has amply demonstrated that a small margin of superior performance is frequently a major factor in maintaining supremacy in the air. This therefore leaves the engine builder with no alternative except to produce an engine of the maximum durability combined with the highest degree of performance which the state of his art permits.

In addition to facing the necessity for an extraordinary expansion without sacrifice in quality of product, the production

Contributed by the Aeronautic Division and presented at the Annual Meeting, New York, N. Y., Dec. 2–6, 1940, of The American Society of Mechanical Engineers. In presenting the paper, the author digressed from the text to illustrate current trends in the manufacture of aircraft engines and showed a motion picture of actual machine-shop practice.



SEMIAUTOMATIC EQUIPMENT FOR ENAMELING AIRCRAFT-ENGINE CYLINDERS

man must decide what changes in the manufacturing process are justified to accelerate production and reduce the man-power requirements of the factory. The powerful urge to adopt new processes better adapted to line-production requirements than was the equipment used under previous circumstances must be tempered by the fact that any disruption in the schedule resulting from such changes will bear painful penalties.

Having thus reviewed briefly the problems facing the production organization, we shall now look at what is actually happening to the factory.

FOUR METHODS OF DESIGNING PLANTS FOR INCREASED CAPACITY

All engine manufacturers are enlarging the capacity of their base plants by rearranging to accommodate new machine tools and by additions to plant structure. The Pratt and Whitney aircraft-engine plant at East Hartford has been increased to several times its original size, and is an excellent illustration of expansion by multiplication of substantially similar manufacturing process units. This procedure has some basic advantages: It does not require drastic changes in process tools; it is relatively free of the risk of the production troubles which always follow introduction of new methods; and it utilizes the established skill and experience of factory personnel without disruption in the established system of operation. It also has a major advantage in that the same step-by-step changes can be followed in the reverse order if and when it becomes necessary to contract the volume of manufacturing operations. The separate but similar units of manufacturing capacity can be used or closed as necessary, without drastic effect on the capacity or utility of the remainder of the plant.

The Wright Aeronautical Corporation has not expanded its base plant capacity by multiplication of nearly similar manufacturing units in the manner adopted by the Pratt and Whitney Aircraft Co. The Wright plant has been expanded as a single process unit by enlarging each general type of manufacturing operation and by changing the equipment used to suit the larger job. This does not imply abandonment of the original equipment, because all of it can be used economically in the smaller job-lot operations which must be carried on together with the large defense-program orders in order to take care of demands for parts and obsolescent equipment which are always present to plague the production men. The plan for expanding facilities followed by Wright has the marked advantage that operations methods best adapted to a larger manufacturing volume can be utilized, thus saving space and man power. Such changes in manufacturing methods carry with them attendant troubles in personnel training and supervision, but the plan is sound because the current job is basically different from the engine builders' task in 1938. If acute contraction in volume of manufacturing operations follows the current expansion, the single-unit unified plant will have tobe dismembered to provide material for a smaller scale of operations, as it obviously cannot be operated in sections.

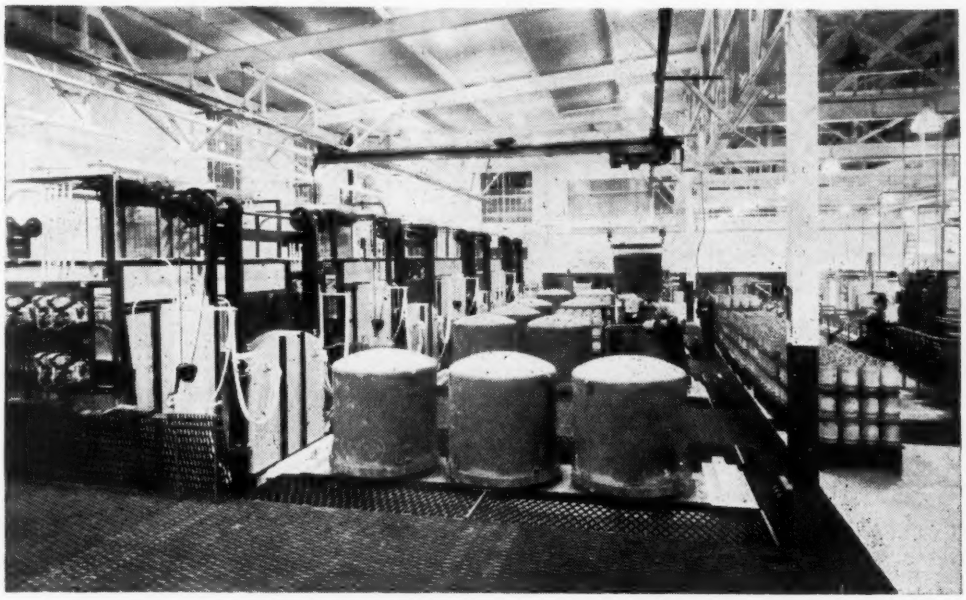
A more completely integrated manufacturing unit being built by Wright is to be operated as a subsidiary factory at Cincinnati. This is different from the two plants previously mentioned in that it is designed to fabricate only one type of engine in relatively large volume, and it is therefore laid out for line production and incorporates a maximum of mass-production methods. It is by far the largest production job yet planned in the United States for the manufacture of a single type of aircraft engine. In it are incorporated many changes in process which promise considerable increases in productivity, and yet appear reasonably certain of producing satisfactory results. While it is a single-purpose plant, it has been designed so that it can readily be converted to other uses should occasion require.

A fourth type of expansion in capacity for production of aircraft engines is being provided by licensees such as the Ford Motor Company, who are building a fine new plant for manufacture of a Pratt and Whitney engine. All of the engineering and production experience of the licensor is made available to the new plant, including all details of operations and tooling. This is subject to searching scrutiny by the licensee, who is free to make such changes in process as he may believe are desirable. This kind of arrangement provides a fine opportunity to utilize the methods and experience of the automotive industry in the production of a standardized aircraft engine in a modern plant designed for that specific purpose. The long-standing desire to wed the skills of these two industries will at last be accomplished. The results will undoubtedly astonish all concerned.

The automotive industry is also undertaking to fabricate a large volume of parts and subassemblies for aircraft engines. This involves close cooperation between the two industries, and the automotive-production men, after a careful study of the aircraft-engine manufacturers' operations, have in most cases endorsed and adopted the latter's basic plan of procedure. This is a real tribute to the aircraft-production men who selected the tools and methods for the job in hand. A goodly fraction of the able personnel in both industries have long cooperated with their mutual aid, the machine-tool builders, in process development. It is no surprise to either group to find themselves in general agreement on the methods to be used in a specific production problem. The loose talk of revolutionary changes following contact between automotive- and aircraft-engine production staffs has disappeared as thin wind, but this does not mean that real and substantial improvements will not result

from present closer contacts.

Every factory job has at least one knotty problem, and the manufacture of aircraft engines is fully laden with its share of production troubles. The need for practically 100 per cent uniformity follows directly from obvious safety requirements and the incessant cry for less weight and more power output. This triangular demand provides plenty of trouble in the fabrication of propeller drive gears. The best designs involve multiple-contact gearing and high unit loads on contact surfaces. This practice is permissible only if all parts are made with high-strength materials, and hardened contact surfaces, as well as extremely uniform dimensions and surface finish. This combination excludes the use of shaving as a finishing process, forcing the use of slower and more expensive gear grinding. This is a typical example of the kind of problem which prevents the adoption of all mass-production methods which have proved suitable in other fields.


BATTERY OF ELECTRIC FURNACES FOR NITROGEN HARDENING OF CYLINDER BORES

SOME AIRCRAFT-ENGINE PRODUCTION FIGURES

A better idea of the improvements effected by the introduction of high-production machine tools and proper planning may be had by quoting actual figures. The master connecting rod of one radial engine, for example, has not recently been altered in design in any manner which might tend to simplify production; nevertheless, the production time on this part has been reduced from 32 to 20 hr within a period of one year, entirely by the use of new equipment and careful operation planning adapted to a larger production schedule.

Another example of savings effected by use of line-production equipment is the case of cylinder painting. One man could produce 10 cylinders per shift by using manually controlled spray equipment. In the same time, 6 men now produce 200 cylinders with a semiautomatic machine, a reduction of 70 per cent in the labor required per unit.

An aluminum crankcase weighing 90 lb, used in a 1000-hp engine, was produced in a total time of 29 hr. It was replaced, to improve durability, with a steel crankcase, weight 125 lb, production time, 142 hr. This sacrifice in cost and weight was painful but necessary to maintain a high standard of safety. Thanks to cooperation between designers and production men, and with help from a larger schedule, an improved type of steel crankcase for the same engine was reduced to 90.5 lb weight, and is produced on improved tools in only 58 hr. The engine power output has also been increased by 20 per cent, a level scarcely possible with the previous material. The net result is a more durable product, and some saving in weight per unit of power output, but a moderate increase in unit cost. Some may say that the increased cost is inadmissible, but it should also be observed that American aircraft-engine prices (9 to 11 dollars per hp) are lower than for other comparable products.

In the last year, in a period wherein actual engine production was approximately trebled, substantial reductions were made in the man-hours required for the production of a group of important subassemblies in the Cyclone 9 engine. For this group of parts, the machining time was reduced 24 per cent, and the foundry time, 12 per cent. For similar parts of the Cyclone 14 engine, the shop time was reduced 26 per cent, and the foundry time, 10 per cent. Some of these savings may be attributed to minor simplification in design and finish requirements, but by far the greater part is credited to careful production planning and utilization of the latest developments in machine tools. As production increases, the lot sizes will also increase with a corresponding reduction in set-up time required. It is anticipated that an additional saving of about 5 per cent in machine time will result.

These savings were effected during a period in which 3000 unskilled men were given a short course of training and absorbed in the shop force. When they attain a full measure of productive skill, results will naturally improve further.

All these encouraging results have not been attained without paying a substantial toll in other ways. Shop scrap has increased by 25 per cent, and personnel training costs are a large sum. Other similar items make an imposing total, but the net result is that the job assigned is being accomplished nearly as scheduled and at a cost which can reasonably be justified by current circumstances.

This discussion has covered the outlines of the current problem of multiplying production output without sacrificing the durability and technical performance characteristics of our aircraft engines. It has reviewed the methods followed by various agencies to increase productive capacity and the fine cooperation between the automotive, aircraft, and machine-tool industries in adapting existing methods to a new production job. The results now becoming visible show gratifying progress in larger production volume and increased productivity per man hour of employment. Technicians, supervisors, and factory workers are all pulling together to reach production peaks, but there are many serious problems yet to be solved.

All our efforts toward increased productivity and a better product will be lost unless we can effect over-all economies so as to permit us to compete effectively in postwar commerce. American leadership in aircraft transportation will depend on our ability to manage this young giant we are creating. Properly directed, it may secure for the aircraft industry a position analogous to that of our automotive industry in its field. Our obligations are manifest.

Application of PHENOLIC ASBESTOS COMPOSITIONS *in* CHEMICAL EQUIPMENT

By WM. H. ADAMS, JR.

HAVEG CORPORATION, NEWARK, DEL.

PHENOLIC resins have long been known to possess good resistance to corrosion, especially acid corrosion. In the early days, however, application of phenolic resins to corrosion problems was limited because the process of molding restricted the user either to simple shapes, like sheets, rods, and tubes, or to small molded articles which could be produced in multiple-cavity molds under heat and pressure, and because most of the early fillers—wood flour, cotton, or some other form of cellulose—were ultimately affected by the acid.

The development of full-size commercial equipment awaited the discovery of a new molding technic, which consists in the loading of a putty-like composition into simple inexpensive molds. The process eliminates completely the use of hydraulic presses and cumbersome hardened-steel molds which would be required to resist the heavy pressure.

By eliminating the hydraulic press and the need for high pressure, it is possible economically to produce large equipment, like cylindrical tanks 9 ft in diameter. Although such a process could also be applied to compositions containing cellulose as a filler, the product would not have the necessary chemical resistance to severe corrosion. Consequently, development of other fillers was necessary. Asbestos was finally selected for this purpose. Asbestos adds to the strength of the composition because of its fibrous nature.

The more common varieties of asbestos are not sufficiently acid-resistant, and it is necessary to use a special asbestos which must be digested in acid to remove its soluble elements.

PROPERTIES OF THREE GRADES OF THE MATERIAL

The phenolic-resin asbestos composition made by the process roughly outlined in the foregoing paragraphs is known under the trade name Haveg. Three grades of this material are available. The first and the most commonly used grade is resistant to practically all inorganic acids except oxidizing agents like nitric and concentrated sulphuric acid. It is resistant to most salts, to some of the weaker bases, to chlorine, and to many solvents. It is not resistant to oxidizing agents, strong bases like sodium hydroxide, or acetone or similar solvents.

The second grade which has a carbonaceous filler instead of asbestos is resistant to hydrofluoric acid, and although it is also resistant to other acids, its use is usually restricted to fluorine compounds.

A third grade, recently developed, is primarily resistant to the strong bases like sodium and potassium hydroxide, and also to most inorganic acids. It can, therefore, be used in either acid or basic equipment.

Contributed by the Subdivision on Rubber and Plastics of the Process Industries Division and presented at the Annual Meeting, New York, N. Y., Dec. 2–6, 1940, of The American Society of Mechanical Engineers. Abridged.

All standard grades of the material are resistant physically and chemically, up to a temperature of about 265 F. Above 265 F the application is usually of doubtful value and must be tested before adoption. The material is not subject to damage from thermal shock, and hence no particular attention has to be given to the rapidity of temperature changes.

The material is supplied in the form of cylindrical, rectangular, and odd-shaped tanks, pipe, valves and fittings, fume duct, fan housings, pumps, drying trays, crystallizers, agitators, textile agers, absorption towers, sheets, and many items not so easily classified which are generally of cylindrical or rectangular shape. Irregular and complicated shapes can be produced, such as cone-bottom and round-bottom tanks and tanks containing baffles or cells.

One limitation of the material is size. For instance, in considering pipe or cylindrical tanks, the largest available diameter is 9 ft. The maximum depth depends on the diameter, and is generally about 10 to 12 ft. The limitation in length is not particularly important because it is a simple matter to bolt together a number of smaller sections to make a deeper tank. With rectangular tanks, the same conditions apply. Seamless one-piece tanks are restricted to about 10 to 12 ft in length, but tanks up to 90 ft long are produced by bolting flanged sections together. Such tanks are often required, especially for some of the more modern continuous strip pickling processes.

The material is generally used in stationary equipment. It is not usually satisfactory for moving parts, especially if these are large. Exceptions are pump impellers, agitators, and tumbling barrels. It can stand shocks or blows, but should not be subjected to abusive shock, such as would be encountered, for instance, by dropping a load of steel into a pickling tank.

The resistance of the material to abrasion is fairly good. The material is actually used for wear plates in certain wire-pickling processes. Scratches and gouges need cause no concern because the material is not a lining but is corrosion-resistant throughout its entire mass. Nevertheless, it will not resist for long the grinding action of sand particles or the direct impingement of a high-velocity steam jet.

The physical-strength properties of the first grade of the material are as follows: Tensile strength, 2500 psi; compressive strength, 10,000 psi; flexural strength, 5000 psi; and shearing strength, 3500 psi.

With metals, such short-time strength values would be used in design formulas with normal safety factors. With this phenolic-resin asbestos material, however, such a procedure would be not only bad practice but might actually lead to an incorrect result, because the material has many of the properties of a plastic. A true plastic is permanently deformed by load, no matter how slight. A truly elastic material, on the other hand, returns to its original dimensions. The material under discussion combines these properties. It may

FIG. 1 CYLINDRICAL TANKS, 5 FT DIAM, EQUIPPED WITH COVERS AND REINFORCED WITH STEEL BANDS

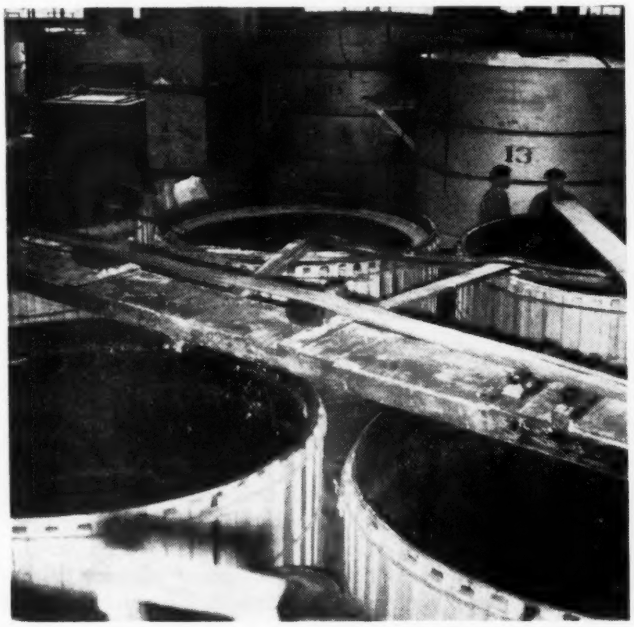


FIG. 2 CYLINDRICAL TANKS, 9 FT DIAM, 5 FT DEEP, REINFORCED WITH VERTICAL WOOD STAVES AND STEEL HOOPS

be permanently deformed under loading conditions well within the safe limits predicted from the short-time ultimate-strength figures. This tendency is noticeable at room temperature and becomes marked at 265 F.

Actual data on the allowable loads under which this permanent deformation is negligible are meager and not reliable for practical use. In practice, the condition is met by applying external steel or wood reinforcements except where loading conditions are well within the proportional limit.

Wall thicknesses of tanks and similar products made of this material are therefore determined more by the necessities and conveniences of the molding operation than by the ultimate strength of the material. For example, the thinnest wall that is practicable is $^1/_4$ in., and the maximum is about $2^1/_2$ in.

The molding process also imposes other limitations. For example sharp angles are to be avoided when possible; and where they are essential, an adequate fillet should be provided. Similarly, sharp changes in wall thicknesses are bad practice. It would not be recommended for instance to mold together a tank wall $1^1/_2$ in. thick with another wall $^1/_4$ in. thick. Outlets, pipe connections, and other openings can be provided, but the types recommended consist of molded-in nipples or bosses containing inserts for bolting. Pipe threads are almost never recommended.

Completely closed hollow articles cannot be produced, but articles which have only one opening can be. In the case of a cylindrical tank, for instance, both heads can be molded integrally with the wall provided a manhole is included.

Complicated internal designs, such as baffles, cells, and coil supports, offer no particularly serious problem. Obviously, however, the greatest permissible simplicity should be retained in the interests of economy.

EXAMPLES OF PHENOLIC-RESIN ASBESTOS COMPOSITION CONSTRUCTION

Cylindrical Tanks. Tanks can be produced having outside diameters up to the 9-ft maximum. The smallest sizes require no external support, which means that stresses are well within the proportional limit. Intermediate sizes require support, which is provided by the use of simple steel bands, Fig. 1, while the largest sizes are equipped with vertical wood staves and with steel hoops, Fig. 2.

Horizontal cylindrical tanks are less common, but can be produced. Such tanks have been built to withstand pressure up to 15 psi, but are not recommended for use above this pressure. Vacuum tanks, up to 4 ft diameter, have been produced, with the walls reinforced internally by means of molded-in ribs of the wall material.

Absorption and scrubbing towers, such as used by the chemi-

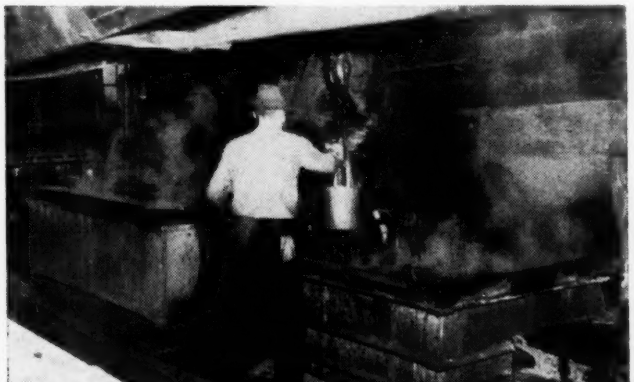


FIG. 3 SMALL ONE-PIECE RECTANGULAR PICKLING TANK WITH THREE STEEL SUPPORT RIBS

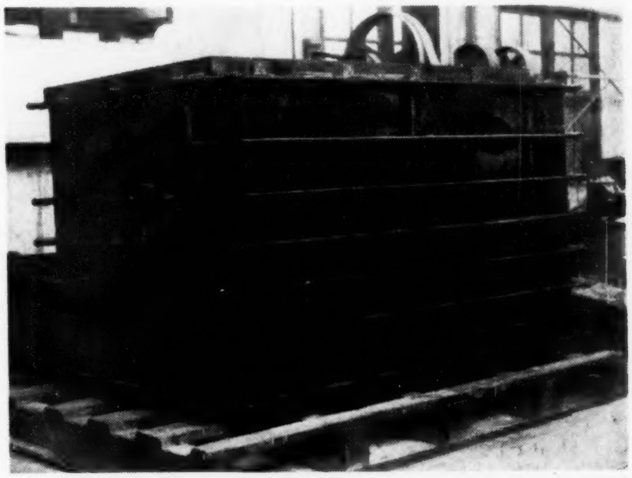


FIG. 4 LARGE, DEEP, RECTANGULAR TANK WHICH REQUIRED EIGHT SUPPORT RIBS

cal industry, are essentially deep cylindrical tanks. The design is basically the same as that of cylindrical tanks, but usually it is necessary to use two or more sections, bolted together by means of split steel angle rings set in slots. A perforated plate is usually included to retain the packing, and inlet and outlet connections for gas and liquor are usually provided.

Rectangular Tanks. As in the case of cylindrical tanks, practically any size rectangular tank can be produced within the maximum. Economy and size standardization are achieved by the use of a mold, the exterior parts of which are built of interchangeable 6-in. squares. With this mold, it is possible to produce any outside dimension of length, width, or depth, provided it is a multiple of 6 in.

Wall thicknesses of rectangular tanks vary from $^1/_2$ to 1 in. Shallow tanks (up to 12–18 in.) need no support, but for long and relatively deep tanks, a support structure is used to prevent permanent deformation. The structure consists of a set of steel ribs, bolted around the tank as shown in Figs. 3 and 4.

One-piece rectangular tanks can be made up to a maximum dimension of 10 to 13 ft, depending on the diagonal of the cross section. Frequently, however, tanks considerably longer than this are required, especially for continuous pickling service. Such tanks are made by bolting several sections together by one of several methods. The most common method is a simple flange construction as shown in Fig. 5.

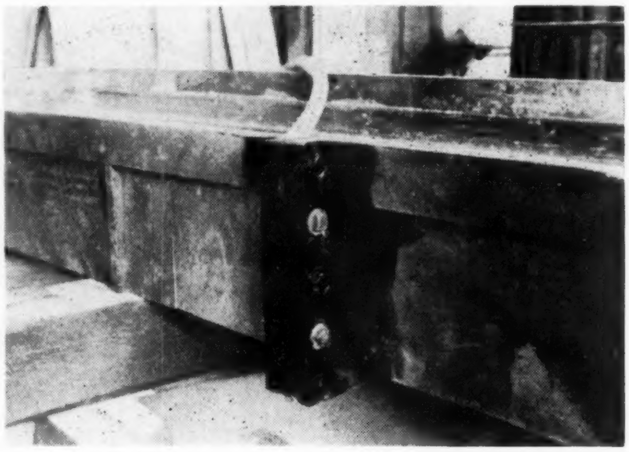


FIG. 5 FLANGE CONSTRUCTION FOR BOLTING TOGETHER SECTIONS OF A LONG, SHALLOW, PICKLING TANK

Pipe and Fittings. Pipe and fittings made of the phenolic-resin asbestos composition described in this paper are available in standard sizes ranging from $^1/_2$ to 12 in., and in larger sizes for special applications. For connection, a split cast-iron flange is set in a tapered slot machined near the end, with a gasket between the pipe ends as shown in Fig. 6.

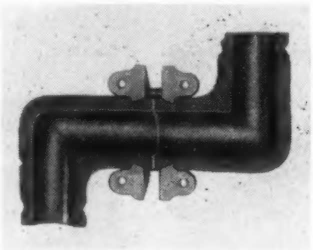


FIG. 6 METHOD OF CONNECTING PIPE BY MEANS OF SPLIT FLANGE

The wall thicknesses of the pipe are determined mainly by manufacturing considerations, and provide for a maximum pressure of 60 psi. The pipe can be cut to exact length in the field, and the ends machined in an ordinary lathe. Valves are made with bodies of the phenolic-resin asbestos composition, and rubber or composition diaphragms which effectively seal the working parts from corrosive liquid. An installation of piping and valves of this material is shown in Fig. 7.

Fume Duct. For handling or disposing of noxious gases and acid fumes, light-wall fume duct is available in sizes up to 36 in. This duct is not intended for use where the pressure is more than a few inches of water. It is usually supplied in a flanged construction, but can also be made with bell ends.

With hydrofluoric acid, the second grade of the phenolic composition, noted in the early portion of this paper, is used. It has about the same tensile and transverse strength as the first grade, but it has a much lower resistance to shock and can be broken by a moderate blow. Products made of it are usually limited to a maximum dimension of about 4 ft. Up to this limit, the wall thicknesses are 50 per cent greater than for grade one and the supports are the same. Because of its relative fragility, this second grade is practically never used except with hydrofluoric acid and related compounds.

The third grade utilizes a somewhat different type of resin and is resistant to strong caustic as well as acids. Its resistance to shock is excellent. As compared to grade one, its physical strength is somewhat less, however, and it is softer and more liable to permanent deformation in the absence of support. It is a relatively new development, and up to the present, the largest equipment that has been produced from this grade consists of tanks about 5 ft diameter by 5 ft deep.

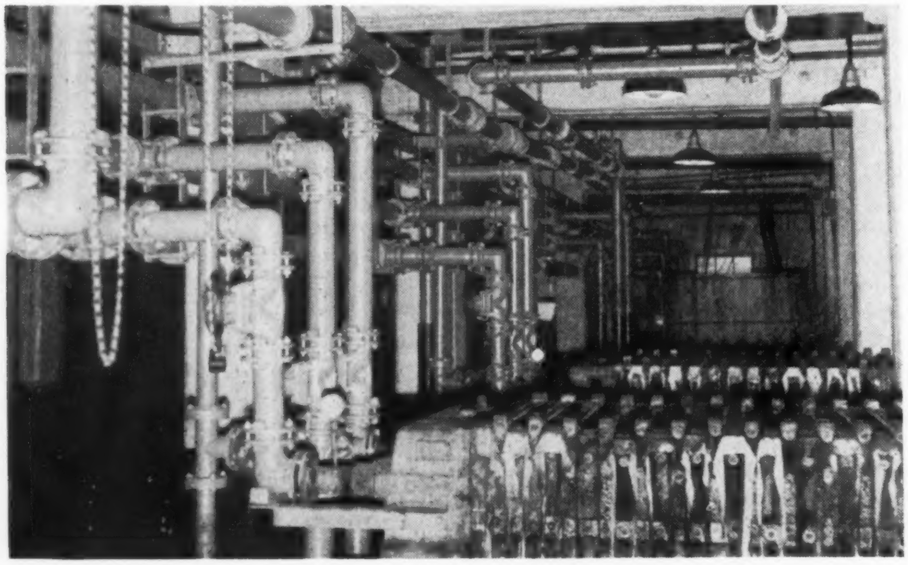


FIG. 7 INSTALLATION OF 2-IN. AND 4-IN. PIPE AND VALVES IN A CHEMICAL PLANT

Training for

NATIONAL DEFENSE

I—The Problem and How the Government Is Meeting It

By A. A. POTTER

DEAN OF THE SCHOOLS OF ENGINEERING, PURDUE UNIVERSITY, AND CONSULTANT, U. S. OFFICE OF EDUCATION

WE ARE in the throes of organizing an enormous program of national defense, which requires for its effectiveness large numbers of skilled workers as well as engineers who are competent in a wide range of technical and managerial services. All facilities must be mobilized to insure an adequate defense program, and the needs for technical talent must be met by setting up special training programs to afford the unemployed and the poorly placed opportunity to prepare for maximum usefulness to the nation.

The defense training program in schools and colleges is either vocational training of "less than college grade" or training on "the engineering-school level."

VOCATIONAL TRAINING OF LESS THAN COLLEGE GRADE

No school can turn out a skilled worker. A good trade or vocational course, however, is helpful in reducing the training period on the job. For twenty-three years the federal government has cooperated with the various states in the development of a nation-wide program of trade and vocational education. As a result of this there are available at present in this country 1053 public vocational and trade schools which employ more than 5000 teachers and which have a combined plant valued at about one billion dollars. The U. S. Office of Education is the regular government agency which is authorized by Congress to cooperate with the state vocational boards in vocational education programs. On May 29, 1940, the U. S. Commissioner of Education made a proposa' for utilizing these schools for preemployment and for supplementary training of workers needed in the national-defense program. This has resulted in an Act of Congress which appropriated to the U. S. Office of Education for payment to the states a sum of $15,000,000 for a summer and fall training program of "less than college grade." This act was signed by President Roosevelt on June 27, 1940.

Exactly one month later or on July 27, 1940, more than 75,000 people, mostly from WPA and unemployed groups, were being trained in 41 states, utilizing the shops and other existing facilities in schools supported by the public. A total of 107,757 persons enrolled during the first two months of operation of this type of vocational training. Congress appropriated on Oct. 9, 1940, an additional twenty-six million dollars to the U. S. Office of Education to be allotted to the state boards for vocational education to permit the training during the remainder of the school year, without interference with the regular school programs, of about 500,000 people in skills of special value to the national-defense program. This is being accomplished in some localities by operating public trade and vocational schools on several shifts. This proposal will afford supplementary training for employed workers and retraining for unemployed mechanics.

On Oct. 9, 1940, Congress appropriated, in addition to the aforementioned twenty-six million dollars, eight million dollars for the purchase, rental, or other acquisition of equipment for vocational schools and ten million dollars to help equalize the opportunities for youth, especially youth in rural areas, to prepare them for service in the national-defense program. These eighteen million dollars will also be spent under the authority of state boards for vocational education.

The facilities of public trade schools may also be utilized in the interest of national defense by improving the skill of those enrolled in CCC camps and in NYA. About seventy per cent of the 1500 CCC camps are so located that 150,000 enrollees in such camps can use vocational-training facilities of public schools in near-by cities during the late afternoon and evening. The trade skill of 267,000 NYA enrollees can also be increased and their chances for employment enhanced by utilizing the facilities of public trade schools. On Oct. 9, 1940, Congress appropriated $7^1/_2$ million dollars to afford vocational and related instruction to young people employed on work projects of the NYA.

Thus, on Oct. 9, 1940, Congress appropriated forty-four million dollars to be expended for vocational education of less than college grade under the authority of the state boards for vocational education and $7^1/_2$ million for the same purpose for the benefit of those on NYA work projects, or a total of $51^1/_2$ million dollars. Adding the fifteen million dollars appropriated last July, the funds available for vocational education of less than college grade for the fiscal year ending June 30, 1941, is $66^1/_2$ million dollars.

CIVILIAN-PILOT-TRAINING PROGRAM

Under the direction and stimulus of the Civil Aeronautics Board 11,000 youths were trained during the last year as airplane pilots at 435 universities and colleges. The flight-training program which is being continued at more than 500 educational institutions during the present year will result in a supply of intelligent pilots, an important need for adequate national defense. It is expected that about 50,000 pilots will be trained at colleges and universities between July 1, 1940, and June 30, 1941.

TRAINING BY THE ADVISORY COMMISSION TO THE COUNCIL OF NATIONAL DEFENSE

The Advisory Commission to the National Defense Council has set up a program of cooperation with defense industries in order to increase the effectiveness of their skilled workers and supervisory personnel. The Advisory Commission to the National Defense Council does not expect to do the actual training but

A group of papers contributed by the Committee on Education and Training for the Industries and the Management Division and presented at the Annual Meeting, New York, N. Y., Dec. 2–6, 1940, of The American Society of Mechanical Engineers.

stands ready to aid industries interested in improving their training techniques.

TRAINING ON THE ENGINEERING-SCHOOL LEVEL

To an extraordinary degree our national-defense program, as well as our ability to meet industrial competition, depends upon science and technology. There is already an acute shortage of technical and supervisory engineering talent in certain of the industries concerned with national defense as well as in the Army and Navy. The airplane industry reports a definite shortage in stress analysts, test engineers, and airplane-power-plant designers as well as draftsmen. Thousands of additional engineers are needed who are competent as designers of tools, dies, jigs, templates, as well as in part analysis, shop layout, and estimates of labor and materials. Thousands of additional inspectors are needed by the Army, Navy, and industry with knowledge of materials, physical testing, inspection of foundry products for materials used in ordnance, X-ray inspection of welded parts, radiographic technique, and other special problems. Inspectors are also needed for automotive equipment, explosives, and radio equipment. Several hundred additional professional meteorologists are needed by the U. S. Weather Bureau and by the Army. The Maritime Commission, the Navy, and the shipbuilding industry report substantial shortages in naval architects and marine engineers; this shortage is particularly serious in that only three engineering schools (Massachusetts Institute of Technology, University of Michigan, and Webb Institute) offer programs of study in this field and graduated only 51 this year.

Besides the needs for thousands of additional engineering specialists industry is confronted with a shortage of industrial engineers and supervisors to speed up the production of equipment needed in national defense, engineers who are familiar with industrial organization, time and motion study techniques, production control, materials handling and storage, inventory, budgetary and accounting control, industrial safety, personnel administration, and industrial relations. Expanding production in some of the defense industries is being accomplished by dilution and overloading of the top management organization.

There are in this country about 165 institutions which offer instruction leading to degrees in engineering. Of these 121 offer one or more curricula approved by the Engineers' Council for Professional Development.

The engineering schools of the country realize that they must maintain in the present emergency the strongest possible programs of undergraduate and graduate study and must increase their research efforts in order to insure a supply of competent and creative engineers. At the same time nearly all of these engineering schools, including the best known, have offered to the U. S. Office of Education, the regular government agency which has cooperated with higher education for many years, fullest cooperation in the training for national defense.

It is impractical to speed up the present undergraduate engineering programs of study, but an analysis by the U. S. Office of Education of the immediate needs for special training on the engineering-school level and of the special facilities available at such institutions for training leads to the conclusion that engineering schools with special facilities should be utilized in one of the following ways:

1 Institutions which are located in large industrial centers, such as Pittsburgh, may be able to utilize their staff, equipment, and classrooms for in-service training of special value in upgrading the supervisory and technical personnel of defense industries. This type of in-service training would be carried on mainly outside of working hours. Some industries may be interested in allowing some of the training to be given on company time.

2 Institutions which are not located in or near industrial centers may carry on certain types of in-service training on the engineering-school level through extension classes. In such cases institutions may have to utilize classrooms and laboratories of public schools or of industry and have the instruction carried on by regular part-time teachers or by special teachers assigned to industrial centers.

3 Intensive resident programs of study, varying in duration from one to eight months. Most of such short-term courses should be available to those who have had the equivalent of at least the first three years of a recognized engineering-school course and actual industrial or engineering experience but who lack specialized knowledge in the field in which there is now a shortage of engineers. Thus, the average mechanical engineer, through a twelve or sixteen weeks' course, could be prepared for employment as a marine engineer, an aeronautical engineer, or for production supervision, particularly if that engineer has had considerable practical experience. In the case of commissioned officers of the Army and Navy, intensive courses of one or two months may prove helpful to them in dealing with Diesel engines, high-pressure steam plants, electric communication, cryptography, metallurgy, meteorology, chemistry of explosives, or similar problems which have been developing very rapidly.

On Oct. 9, 1940, Congress appropriated nine million dollars to the U. S. Office of Education to be used in reimbursing engineering schools operating under charters which exempt their educational property from taxation, for the administration of the foregoing types of in-service instruction as well as for special intensive courses in fields in which they have special facilities in staff and equipment.

Actual and potential needs for additional technical and supervisory personnel will determine the specific courses to be offered and every effort will be made to maintain a continuous balance between the supply of trainees and demands for their services. The first courses to be established will be designed to forestall potential shortages of inspectors of materials, chemicals, explosives, instruments, and power units; designers of machinery equipment, tools and dies, and aircraft power plants, structures, and instruments; production engineers and supervisors; physical metallurgists; marine engineers and naval architects. As other needs become apparent, additional courses will be added to this program.

INSTITUTIONS TO DETERMINE QUALIFICATIONS FOR ENROLLMENT

Qualifications for enrollment will be determined by the institutions giving the courses in accordance with general rules suggested by the U. S. Office of Education. In most cases, students will be selected from those who have previously had some technical training or its equivalent in practical experience which must be refreshed or supplemented to fit them to perform specific technical or supervisory duties. The program will not conflict with the vocational training courses also being administered by the Office of Education through the several state boards for vocational education, nor will it displace regular undergraduate courses given by the cooperating colleges.

Institutions desiring to take part have already been invited to submit preliminary plans stating the need for trained technicians in their areas, the facilities and personnel they have available for giving the necessary courses, the number of students that can be taught, and the approximate cost of instruction. These plans will be adjusted to a coordinated plan for the country as a whole, after which authorization will be given to proceed with the enrollment of students.

Federal allotments to the participating colleges may be used to meet the costs of salaries, materials and supplies, reference books, the operation of buildings, the maintenance and repair

of equipment, and, to a limited extent, the purchase or rental of additional equipment and the leasing of space in noncollege buildings. No expenditures are authorized for the purchase or construction of buildings, nor is provision made to defray the living expenses of students. Students will pay no tuition charges.

To determine training needs as they develop, the Office of Education has just completed arrangements under which selected colleges and universities have made available 22 regional advisers who will serve without compensation. Each of these will act, within his own territory, as a liaison officer maintaining continual contact with defense industries, Army and Navy district offices, employment services, and other sources of information on personnel needs, as well as with local engineering schools equipped to meet demands for training courses as they arise. These men will keep the Washington headquarters continually informed so that deficiencies in any one region may be met, if necessary, by training students in other places where facilities are available. In this way a national program will be evolved that will continually adjust itself to changing conditions both in industry and as regards the technical personnel requirements of the federal government. Authorization of courses will not only conform to the needs so developed, but will also take into account the staff, equipment, and buildings at the various institutions and the availability of qualified students.

Detailed outlines of the ground to be covered in each in-service and intensive course on the engineering-school level are now in preparation by the U. S. Office of Education. These outlines are intended to cover training programs of value to defense industries, the Army and Navy, and must in most cases be in line with Civil Service Commission requirements, as all civilian technical employment by government must have the approval of the Civil Service Commission.

As the program develops arrangements will be made to facilitate the placement of students in defense positions as they complete their training. Much of this will be done by direct contacts between the engineering schools and near-by industries, but students will also have available the facilities of state and federal employment offices and the U. S. Civil Service Commission.

An Advisory Committee on Engineering Training for National Defense, which is representative of the engineering teaching profession, has been set up by the U. S. Office of Education to aid in formulating policies for the in-service and intensive-training programs on the engineering-school level. It is hoped that these programs will prove helpful to the National Defense Program by meeting the needs of the Army, Navy, and of defense industries.

Engineering colleges are greatly disturbed by reason of the selective draft, the call to active duty of the National Guard and Officers' Reserve, by the present need of industry for additional engineering talent, and by the danger of the depletion of their teaching and research staffs. They are also experiencing great difficulty in finding additional teachers to take care of the defense-training program. Engineering-school executives are fully conscious of their responsibility to insure prompt preparedness and an adequate national-defense program. They realize, however, that we must make certain that every person on our staff renders maximum usefulness during the present emergency, whether it be at his present post or in the direct service of government. In many cases superior teachers can render their greatest service through the training of engineers. It is hoped that industry as well as the defense agencies of government will realize that without effective teachers today there will be no engineers tomorrow to design and build instruments of war and to aid industry in meeting industrial competition which is bound to become more and more difficult. Industrial supremacy as well as military preparedness depends upon competent engineers and scientists.

No one can accurately predict what the future holds for us. Present conditions demand that science and technology operate at full speed. The engineer's initiative and inventive talents must be used most effectively. It is hoped that in-service and intensive-training programs to be administered by the U. S. Office of Education on the engineering-school level will prove helpful in supplying people for key positions in the rapidly expanding defense industries as well as for the Army and Navy. At the same time every effort must be made not to interrupt or to reduce the effectiveness of the engineering undergraduate and graduate programs of study and to increase our research efforts so that an adequate supply of well-educated and creative engineers may be assured.

II—Need for Training on College and Subcollege Level as Seen by U. S. Civil Service Commission[1]

By E. J. STOCKING

PRINCIPAL EXAMINER (ENGINEERING) U. S. CIVIL SERVICE COMMISSION

EXECUTIVE order No. 7916 of June 24, 1938, authorizes and directs the establishment of federal training facilities in and by the departments and agencies and by the Civil Service Commission. Among other functions, the Division of Personnel shall have supervision of the "training of employees in the department or establishment, and shall initiate and supervise such programs of personnel training and management as the head thereof after consultation with the Civil Service Commission shall approve. . . ."

Section 8 reads as follows: "The Civil Service Commission shall, in cooperation with operating departments and establishments, the Office of Education, and public and private institutions of learning, establish practical training courses for employees in the departmental and field services of the classified civil service, and may by regulations provide credit in transfer and promotion examinations for satisfactory completion of one or more of such training courses."

The Commission interprets the first part of Section 8 to mean that it is expected to assume responsibility for assuring the establishment of necessary training courses to meet the needs of the federal service. Such courses may be made available in three ways: First, within and under the direction of the separate departments and agencies for the benefit of their own employees; second, by the coordination of the activities of different agencies or institutions whenever cooperative action is necessary or advisable; and third, by the initiation and direction of certain types of training courses by the Civil Service Commission itself.

The Commission is also very much interested in pre-entry

[1] Acknowledgment is made to Winston B. Stephens, Coordinator and Director of Training, for his assistance and for the use of the information obtained by his office in their survey of government personnel needs.

training or prerecruiting training courses. Such courses may be considered as including the whole educational and vocational experience of eligibles prior to appointment in any federal position. The federal government ordinarily has no connection with the pre-entry training of applicants other than through contact for recruitment purposes with existing employing agencies and educational institutions or through the extended service of the Office of Education in the whole field of learning.

In the present emergency, however, a direct connection of the federal government with pre-entry training has been established through the appropriation of some millions of dollars for the purpose of developing skills in the various trades, industries, and professions necessary for speeding up the defense program. Of course, these moneys were not appropriated with the idea that graduates of such specialized training courses would be made available only to the federal government. Actually, it is expected that by far the greater portion of those trained under these funds will be absorbed in private industry. The various federal departments and the Civil Service Commission are well aware of the shortage of trained personnel in some fields because of the difficulties they have encountered in recruiting for these fields. It is, therefore, necessary and desirable for the Civil Service Commission and the federal departments to work cooperatively with the U. S. Office of Education in the establishment of such courses as will provide, if not adequately trained, at least acceptable recruitment material needed to keep the defense program moving at a rapid rate.

TRAINING AT THE COLLEGE LEVEL

In planning training courses of college and subcollege levels consideration must be given both to the long-range program and to the filling of immediate needs. The engineering colleges are now well organized and well equipped with staffs to handle the long-range program. The problem there is primarily that of determining what shifts in curricula and in teaching personnel are desirable in order better to serve the immediate needs of the country, and to create at the same time a reservoir of trained personnel for use within the next one to five years. The fact that the usual number of trained engineers and technicians will be needed to carry on the regular peacetime activities of the nation should not be ignored. The Civil Service Commission believes, however, that this problem is one the engineering colleges can and will solve on their own initiative.

The short-range or immediate program calls for short courses extending over periods of from 6 to 16 weeks. Possibly a few courses of longer duration are needed. These can be organized either as "refresher" courses, or as highly specialized courses designed to furnish persons otherwise competent with the specialized knowledge which is needed to perform a particular job.

Of course, I believe that no one in this audience would contend that a highly specialized course lasting a few short weeks would in itself equip anyone to assume a responsible position either in industry or in the government. Therefore, there is a great need for determining logically and sensibly what prerequisites should be established for admission to such courses. If those trained in these short courses are to be employed in useful occupations, the background with which they enter the course must be such as to make it apparent to any appointing officer that persons with such training have good possibilities of being able to perform the duties to which they will be assigned. Haphazard training of persons whose services cannot be utilized upon the completion of the training course is much worse than no training at all.

After discussing the problems of recruitment at various times with many of the personnel and appointing officers associated with the defense agencies, I am convinced that the immediate program calls for training in two main fields. The greatest demand is probably for training in the skilled trades, but there is still a real demand for some training in the technical professions. The training needed in both fields should be considered under two main subdivisions: First, pre-entry training, that is, training previous to recruitment and to induction of a person into a position; and, second, in-service training, that is, training for those persons already employed so that they may become more efficient at the tasks on which they are engaged.

The Commission's interest in pre-entry training lies in the fact that it is the central recruiting agency for most of the civilian personnel needed by federal defense organizations. Its objective is to obtain the best-qualified persons possible and thus furnish the departments with efficient and acceptable personnel. It must decide what competitive requirements shall be established in its examinations for any particular position or for any group of positions, and after making the decision must publish these requirements so that the public may be informed of them. There is nothing static about civil-service examination requirements and, as conditions change, or as experience indicates the need of change, requirements can and do change. The Commission and the government departments should therefore be thoroughly familiar with what is being done by the vocational and the engineering schools with the special courses now being organized throughout the country to speed up national defense. Where such courses are acceptable to the Civil Service Commission and to the federal departments as a basis for recruitment of federal personnel, the schools, competitors, and general public should be so informed through new examination announcements, or through amendments to announcements of examinations now pending.

It is my opinion, based on the requests for certification of technical personnel which come to the Commission and on the probability that industry will need a greater number of persons than the government, that the colleges could immediately organize to advantage short courses in the fields of aeronautics, naval architecture, marine engineering, industrial supervision, engineering inspection, and automotive design. To be of maximum help in speeding up the defense work, such courses must of necessity be highly specialized, and in some of the fields mentioned must be so designed as to equip a man to handle a particular phase of the work with a minimum amount of training on the job. For instance, in the field of aeronautics it is desirable to give some persons a practical fundamental knowledge of airplane structures, and such persons should spend a minimum amount of time, possibly none, on the design of propellers, airplane engines, and airplane instruments. That is, if a short course of a few weeks' duration is to impart to an individual enough information to enable him to perform the duties, for which he is being trained, in connection with airplane structural design or inspection a large percentage of his training time must be spent on structures alone. A similar statement can be made with respect to engineering inspectors, and if short courses are resorted to for training inspectors, such courses should be formulated in such a way that persons completing them will be able to perform inspector duties of a specific type. No single general course can be designed that will be satisfactory for the training of all types of inspectors, or for quick training in any fairly broad field of engineering activity.

NEED FOR MACHINISTS AND MACHINE OPERATORS

Intensive courses in the vocational field should give first consideration to the development of machinists and machine operators. The Navy Department estimates that it will need approximately 8000 additional journeymen machinists within the next 12 months and a probable total of 9000 or more within

the next year and a half. The War Department estimates that it will need more than 10,000 machinists, 1000 of this 10,000 being needed for the Air Corps alone. By the end of two years, therefore, upon the basis of present estimates and plans somewhat over 20,000 additional journeymen machinists will be required by the War and Navy departments. Definite estimates as to the needs of industry are difficult to obtain. It is believed, however, that fully 85 per cent of the munitions for the Army and Navy must be furnished by private industry. Likewise private shipyards will undoubtedly be obliged to undertake far more than their normal share of the construction of naval vessels. The 20,000 additional machinists needed at arsenals, airfields, and navy yards will be but a minor part of the total number of machinists that must be provided within the next two years.

If we take the term "machinist" to mean a person who sets up and uses skillfully all machine and hand tools, very few fully trained journeymen machinists are unemployed at present. Of the 22,000 machinists who were registered with the Employment Service Division of the Bureau of Employment Security, as of April, 1940, many have since been employed and many others do not have the qualifications or suitability needed for employment in munitions factories and arsenals. The International Association of Machinists estimated in August, 1940, that 10,000 unemployed machinists were available, but various other labor-union officials have intimated that no large surplus of machinists is available at this time. Both the government and private industry are having difficulty in recruiting enough competent machinists to fill their current needs. This would not be the case if the number of machinists willing and able to do the work required were greatly in excess of the demand. It is impossible on the basis of available data to estimate the number of journeymen machinists employed now at some other trade or occupation.

However, there are doubtless a number of them, especially among those persons who were over 40 when the depression threw them out of work. Many of these probably are listed by the employment offices but may be unemployable because of age or because of physical disability. The demand for machinists is already causing a considerable number of persons to move from one industry to another and from industry to government or from government to industry. It is obvious that while a normal flow of labor from one plant to another is to be expected it will not make additional skilled labor available and instead may seriously retard production, particularly if too many persons leave essential work in one plant to accept similar work in another. The question of the transfer of machinists now employed in industries not essential to the defense program, to work in establishments in the War and Navy departments or in industries connected with the defense program, is one that can lead to a great deal of useless argument, as it is almost impossible to say what industries are and what industries are not essential to the defense program.

According to estimates, the number of unemployed machinists and of machinists employed at other occupations who might be available as machinists falls far short of the estimated additional needs of the government and private establishments for the manufacturing of munitions and the building of ships. Unless something is done now, there will be a real and serious shortage of machinists within two years and probably within a shorter period. The forwarding of the defense work and the carrying on of the normal activities of the nation will suffer if this serious shortage does occur.

NEED FOR OTHER CRAFTSMEN

In addition to the need for skilled machinists, there is a definite need for other craftsmen and such advanced workmen as instrumentmakers, toolmakers, and diemakers, etc. The September, 1940, issue of the official publication of the American Society of Tool Engineers gives a final report of the A.S.T.E. survey on the shortage of skilled men in industry. This survey shows an immediate need for 32,570 tool engineers, 127,750 tool and die makers, and 408,816 skilled mechanics, and indicates that an additional 78,208 tool engineers, 281,062 diemakers, and 332,160 skilled mechanics will be required by the time industry reaches the expansion necessary for carrying on the defense program. The survey also intimates that approximately 30 per cent of the plants in the industrial areas of the United States will need additional tool engineers, that between 55 per cent and 60 per cent of the plants in these industrial areas will need additional tool and die makers, and that about 65 per cent of such plants will need additional skilled mechanics. It further indicates that about 30 per cent of the plants have apprenticeship training programs and that 41 per cent have some sort of training that is not well organized or which is very incomplete. Since the survey referred to was made, industry and the vocational schools have been working in close cooperation with the United States Office of Education in an effort to train the persons needed to relieve some of this indicated shortage of skilled mechanics.

It is not believed that any short course, no matter how well it may be organized or how competent the instructor may be, can produce skilled machinists or other types of skilled craftsmen. Such courses may, however, produce machine operators and persons with sufficient skill to carry on one of the operations involved in machinist's work. It would seem, therefore, that the government departments and also private industries will have to give serious consideration to making an analysis of their operations or work flow with a view to using a large proportion of persons with limited skill in rather simplified operations.

A thorough analysis of the work processes both of government and private manufacturing establishments with the assistance of experienced and competent industrial engineers seems to be necessary in order to determine to what extent it will be possible to reorganize operation and work flow so as to use a greater number of machine operators and thus reduce the estimated number of machinists required. Upon the basis of such an analysis, it may be possible to organize vocational courses that will be of great assistance in recruiting, not necessarily skilled personnel, but personnel competent to carry on during the emergency period. Recruiting of such personnel will not completely solve the problem. There will still remain the task of training on the job, the responsibility for which must be assumed by the War and Navy departments in connection with their work and by industry in connection with its work.

Programs of apprenticeship training for machinists should be expanded to a capacity consistent with ability to supervise shop practice and with ability to furnish competent instructors. Of course, some persons now serving as apprentices will complete their training within the next two years and these will serve as one source of supply for additional machinists. Actually, however, such apprentices will probably not be available to any organization except to the organization that has trained them.

POSSIBILITY OF UPGRADING

Many recent graduates of the better vocational and trade schools who have specialized in machine-shop work and who have had the opportunity of gaining some practical shop experience would be among the best material obtainable for training by means of special short courses of an intensive character. This source of supply should produce persons who

can be quickly trained to operate one or two machines satisfactorily.

The general upgrading of machine operators can be promoted and speeded up if special theoretical courses in shop mathematics, shop metallurgy, shop techniques, and shop supervision are made available to those so employed. If the courses are designed for this specific purpose, such upgrading will aid considerably in relieving the shortage of trained machinists that exists.

Naturally, one of the results of rapid expansion in the industrial field is the upgrading of journeymen to supervisory positions. Because of the speed with which advancement takes place all along the supervisory line and because of the pressure to increase production, persons stepping into new supervisory positions do not have the advantage of the usual amount of assistance and instruction from their immediate supervisors. It becomes especially important, therefore, that carefully organized training be given to persons selected to be leading men and quartermen and to those who are to fill other supervisory positions.

The importance of their part of the training program cannot be overemphasized at a time when so many men will be put to work in the shops, who will be undergoing a training in which the supervisors must have a vital part. The expansion of production in industries now established, the building of new industrial facilities, the working of more than one shift of employees, and the large amount of overtime that will be required will tend to keep those who are competent to instruct so employed on actual production that their services and time cannot be utilized for instructional purposes.

Both industry and government may, in their eagerness to keep pace with their plans, try to rob the vocational schools and the engineering colleges of much of their trained instructional staff, leaving a dearth of instructors at a time when there is a real demand for highly competent teachers. Ill-conceived and poorly organized training courses given by incompetent instructors will lead inevitably to severe criticism and disappointment—disappointment to those who have taken the courses because they will find that they are still unemployable, and disappointment to industry and to government because the type of trained personnel which they need is not being made available. Loss of competent instructors by the vocational schools and the engineering colleges can seriously affect the rapidity with which we can get our defense program moving and the effectiveness with which we can maintain it once we have it moving at the speed desired.

ROLE OF CIVIL SERVICE COMMISSION

The Commission is extremely anxious to work with the engineering colleges and with the vocational schools in recruiting personnel for the various federal departments. The Commission relies on American colleges to provide annually the personnel from which to recruit for junior professional positions. These colleges have also served as an excellent source for eligibles qualified for higher-grade professional and administrative positions. As experience has shown that engineering colleges provide the civil service with excellent and well-trained material, there is no reason to doubt that the colleges can do an equally good job of training, by short courses, the personnel needed in connection with the present emergency. Existing vocational and trade schools can assist materially in relieving the shortage of skilled mechanics not only for the government but also for industry by cooperating with the United States Office of Education in conducting the necessary training courses.

As the Commission views the problem, however, the major program of training is largely that of training for industry. Actually, the government departments started their expansion ahead of industry, and have entered the market and secured much of the necessary personnel ahead of industry. It was also possible for the government departments to organize their training program at an earlier date than could industry because industry had to wait for orders before knowing exactly what it could or should do. Again the probabilities are that industry must produce 85 per cent of the material required in the present emergency defense program whereas government manufacturing plants will not produce more than 15 per cent of it.

As the courses on both the college and subcollege levels are organized and begin to turn out trained personnel the Commission will make every effort to keep informed about such courses, and whenever it becomes apparent that personnel so trained can be utilized by the various federal agencies, efforts to recruit from such sources will be made. The Commission is always anxious to cooperate to the fullest extent with colleges, vocational schools, and other federal departments in its effort to bring into the government the very best-trained personnel available.

III—The Navy Training Program for Civilian Employees

BY C. W. FISHER

CAPTAIN, U.S.N., DIRECTOR OF SHORE ESTABLISHMENTS

THE preparedness program has increased tremendously the work load at all the various naval activities such as navy yards, naval air stations, and naval ordnance plants. The new construction, conversion, and alteration work at the navy yards; the numerous aviation projects; and the production of guns, torpedoes, and ammunition at the ordnance plants; all have been allocated on the basis of the maximum output from each facility.

To accomplish this work load quickly and efficiently, the most important factor is an adequate supply of competent workmen. All the classifications and grades are included—the naval architects and marine engineers, the draftsmen, the supervisors, the artisans, the helpers, the inspectors, and the clerical and accounting forces. Each one has a part to play.

The Navy training courses were inaugurated and are designed to augment as necessary the available supply of skilled workmen.

EXISTING FORCE AND REQUIREMENTS—PROCUREMENT

The field force of the Navy totaled 65,000 men in June, 1938; a year later it was 82,000; and in September of this year the total was about 140,000.

Additional men are being taken on as rapidly as they can be absorbed into the system, the present rate being about 9000 per month.

A national emergency creates a great demand for persons skilled in many vocations which in normal times have a limited field. This applies particularly to those engaged in the design

and building of ships and in the design, assembly, and repair of aircraft.

Where shortages occur it is necessary to take the best material available and by training raise the skill and performance to the required degree.

TRAINING

During the last two years the Navy Department has inaugurated and maintained training courses to meet local needs in trades and occupations in which shortages appeared probable, and this system has played a large part in maintaining or anticipating work schedules.

The principal courses maintained are as follows:

Apprentice training
In-service training for artisans and helpers
In-service training for shop instructors
In-service training for supervisors
In-service training for junior architects and engineers
In-service training for inspectors

In addition to the foregoing, all new employees are given a short course to minimize the "break-in" period. All employees in one sense are in training as the rapid expansion brings rapid promotion to those qualified.

APPRENTICE TRAINING

For more than fifty years the Navy has maintained apprentice schools at various navy yards and stations. At present there are apprentice schools at sixteen stations, including ten navy yards, three air stations, and three major ordnance plants. Thirty trades are covered by these schools.

The regular four-year apprenticeship system has recently been modified to allow the advancement of qualified apprentices to journeyman ratings after three years, and the number of apprentices allowed has been greatly increased. In July, 1939, approximately 2000 apprentices were in training—by the end of 1940 it is estimated there will be 4000.

The apprentice schools provide the long-range training, looking to the future for all-around mechanics and for supervisors.

ARTISANS AND HELPERS

The various yards and stations have been authorized and directed to establish in-service training for trades in which shortages are anticipated.

The numbers trained are limited to local needs, the training is practical in character, and the trainees are selected from promising employees.

Where shortages occur, helpers are trained for advancement to mechanics' ratings. Helpers and mechanics also are trained for reclassification in allied trades; for example, boilermakers or shipwrights may be trained for shipfitters; sheet-metal workers for coppersmiths; or machinists for toolmakers.

In 1939 the rating of "helper trainee" was established. This brought in men under 30 years of age who have had two years' experience in a woodworking or metalworking trade, or the equivalent in an organized vocational school. Appointments are limited to local needs and are for a probational period of six months during which the trainee receives at least three months' training. Qualified trainees are reclassified as helper or those with the requisite skill and knowledge may become an artisan, minimum rate, for an additional probationary period of six months.

The principal trades in which training has been found necessary are shipfitter, electric welder, coppersmith, electrician, machinist, loftsman, calker and chipper, molder, instrumentmaker, toolmaker, blacksmith, and ropemaker. At the present time there are about three thousand artisans and helpers in training.

SHOP INSTRUCTORS

In order to insure systematic and efficient training in the shops, selected mechanics are given special training to fit them as on-the-job instructors in the shops.

The training comprises instruction technique and handling men. The shop instructors receive additional compensation for this duty.

SUPERVISORS

Practically all the supervisory positions are filled by promotion within the organization.

The number of supervisors increases as the total force expands, and the courses are intended to fit eligible artisans, leading men, quartermen, and foremen for the next higher position in the shortest time.

About 400 men will receive this training during 1940.

NAVAL ARCHITECTS, ENGINEERS, AND DRAFTSMEN

Early in 1938 the shipbuilding program indicated the need for naval architects, marine engineers, and draftsmen, and the training courses to build up these forces were among the first inaugurated.

This foresight has been well repaid because now when the demands of private shipyards and other plants have exhausted the supply, the navy yards and stations are not suffering the acute shortage which otherwise would obtain.

INSPECTORS

The part of the national-defense program assigned to private facilities has greatly increased the work of the navy inspection forces. The supervisors of shipbuilding, inspectors of naval material, inspectors of naval aircraft, naval inspectors of ordnance, inspectors of machinery, and inspectors of navigational material, give all new employees training under the experienced inspectors to fit them for independent work. The Navy Yard, Washington, provides many inspectors for ordnance materials; the Naval Aircraft Factory is called on for inspectors of aviation materials; and selected artisans from navy yards readily are trained as inspectors of naval material.

ACKNOWLEDGMENT

The Office of Education and State and local boards of education have been cooperative in connection with the training program.

At present there are nine instructors furnished in connection with work at apprentice schools at six navy yards and one naval air station.

Also, vocational-school buildings have been made available for instruction at night and thousands of employees are taking voluntary courses to improve their trade knowledge and technique.

CONCLUSION

The Navy training system has been of material assistance in meeting the emergency requirements. The scope of training and methods used are revised as necessary from time to time to meet current conditions and anticipated future needs.

We still call upon the colleges and technical schools and on associations such as the one you represent for our architects, engineers, and draftsmen; and upon vocational schools for lower ratings, and of course every effort is made to secure the necessary qualified artisans. The Civil Service Commission has been successful in supplying the best men available and with our training system well established, we can look confidently toward the future.

IV—Training College Graduates for the Aeronautics Industry

By R. RANDALL IRWIN[2] and JACOB KADUSHIN[3]

LOCKHEED AIRCRAFT CORPORATION AND VEGA AIRPLANE COMPANY

When the aircraft manufacturing industry was confronted with the huge national-defense program, it already was working under pressure to meet the requirements of large foreign military orders.

During the three years from the summer of 1937 until the summer of 1940, aircraft-manufacturing employment in Los Angeles County alone increased from 7400 to 55,000 persons. It would not be surprising if aircraft employment in Los Angeles County reached 150,000 persons by the beginning of 1942.

It has not been uncommon for an aircraft factory to double or even treble its working forces in three to five months. In the past, engineering personnel has increased in approximately the same proportion as other classes of employees.

NEED FOR SPECIALIZED TRAINING

Because aeronautical engineering is a comparatively new profession, there has never been a reserve supply of qualified personnel in this field. As it became evident that the industry could not secure experienced aeronautical-engineering personnel, it was obvious that the only alternative was to train them.

The college-graduate engineer, whether he majored in aeronautics or some other branch of engineering, cannot be considered as capable of solving design problems in an efficient and practical manner. While this condition applied in some degree to all branches of engineering, it is particularly true in the aeronautics industry.

The college graduate has absorbed a certain amount of fundamental theory. This theoretical knowledge must be supplemented by a thorough understanding of design standards, tooling problems, manufacturing methods, assembly methods, and the various possibilities and limitations involved in the practical problems of efficiently designing and manufacturing a worth-while product.

Besides this training in practical application of the theory he has already learned in college, there is imperative need for further training in some specialized field. To illustrate this need for specialized training let us consider the design of a fairly large modern aircraft.

The time for completing such a design is approximately 250,000 man-hours. If one man were to design the complete aircraft, on the basis of 300 working days per year and 8 hours of work per day, it would take him more than 100 years to complete the design. Even if a man undertaking such a task could guarantee living long enough to complete the work, we are hardly in a position to wait. It is quite evident, then, that the design of an aircraft must be undertaken by a large group of engineers.

As certain portions of the whole design are delegated to various individuals they become experts in solving those problems peculiar to that portion of the whole design. As new designs are undertaken, these engineers are again assigned to the same corresponding portions of the aircraft. Thus they become experts in their specialized field. To cope with the problem of increasing specialization, the college graduate needs additional training.

To meet the need for trained engineering personnel, the Lockheed Aircraft Corporation and Vega Airplane Company have three separate training programs. One is for men now employed in the engineering department; another for recent college graduates about to enter the industry, and the third for graduate engineers with experience in other industries.

In addition to these three programs arranged especially for engineering personnel, we have approximately 6000 employees attending evening trade extension classes in conjunction with the local school system. These classes are available to every employee in our organization to extend his knowledge and ability. They comprise 140 different classes and cover the various trades where skill and technical knowledge are essential. They are mentioned here because in many instances the college graduate finds himself deficient in the technical knowledge necessary for some phase of his work. He can acquire this knowledge by attending the particular trade extension class that meets his need.

Still another type of training program has been inaugurated to meet specific needs. Special courses have been developed to provide training, during working hours, of riveters, template men, loftsmen, tool planners, inspectors, etc. Since these courses have not, in most cases, been composed of college graduates, they will not be discussed at this time.

TRAINING OF MEN ALREADY EMPLOYED IN ENGINEERING DEPARTMENT

Of the three training programs for college graduates, we shall consider first the program for men already employed in the engineering department. The courses in this program consist of one to one-and-one-half-hour lectures, given during working hours. These lectures are given by men recognized as authorities in their field. The students are selected from voluntary enrollees with the help of suggestions from their supervisors as to which course would most aid the student in becoming more adept in his work. Among the courses given are stress analysis, aerodynamics, materials and processes, assembly methods, fabrication methods, and so forth.

TRAINING OF RECENT ENGINEERING GRADUATES WITHOUT INDUSTRIAL EXPERIENCE

The second training program is that for recent college graduates, that is, graduates without any actual industrial experience. The men comprising this program are employed as engineering trainees. They are in a special department for the duration of their training. This is tentatively set at a period of one year. During this time they work in about twenty different departments in the plant, and thus acquire a thorough knowledge of the various methods and problems involved in the manufacture of aircraft. This work is augmented by several hours of lectures each week by outstanding engineers.

The supervisor of each department to which a trainee is assigned sees to it that he is given an opportunity to learn the various functions of the department, by moving him from job to job, as he masters the technique of each operation. The supervisor also reports to the coordinator of the program on each man's ability to learn, his interest in that particular type of work, his attitude, accuracy, speed, and so forth.

The trainee is required to keep a "diary" of his experience in the form of notes on the various operations he performs. He also is asked to make suggestions on possible improvements in the methods of manufacture and design that he has observed. These suggestions are written up with illustrative sketches and

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[3] Assistant Education Manager.

turned in with his "diary" to the coordinator. From the material turned in by the trainee and the reports of the supervisors, the coordinator can get a fairly clear idea of the type of engineering work for which the trainee will be best suited.

With this in mind, the coordinator arranges an informal interview between the trainee and the supervisor of the particular branch of engineering for which the trainee seems best fitted. During this interview, the trainee can obtain a clearer and more definite idea of the nature of the work in the department in which he is destined to find his permanent place. If his interests lie in that field, he can continue his training in a more concentrated manner. Also, in this informal manner, the engineering supervisor can meet and analyze his prospective employee, thus assuring a more equitable placement for the trainee.

TRAINING OF ENGINEERING GRADUATES WITH EXPERIENCE IN OTHER INDUSTRIES

The third of our training programs is that for college graduates, who have had engineering experience in other industries. In view of the fact that this is the first time such a program has been attempted, considerable interest in our efforts has been aroused. For that reason, this program will be discussed in more detail.

Because the previous rapid expansion of the industry had already absorbed all available experienced aeronautical engineers, the sudden demand of the national-defense program could only be met by additional training. To accomplish this training in the shortest possible time, there was evolved a plan for converting engineers experienced in other industries into aeronautical engineers. Because the trainees already would have a knowledge of engineering fundamentals, it would be necessary to cover only the special subjects peculiar to the aeronautics industry. Additional benefits from this procedure would be derived from the fact that the men would bring to the aircraft-manufacturing industry experience in mass-production methods.

With these thoughts in mind, our companies developed a new intensive-training program in conjunction with the California Institute of Technology. As soon as preliminary arrangements were concluded, personnel interviewers were sent to various sections of the country to select carefully one hundred or more prospective trainees. More than sixteen hundred applicants were interviewed and given psychological and professional tests. Of these, one hundred and seventeen men were employed and sent to the California Institute of Technology at Pasadena, California. Their traveling expenses, tuition, and salary while in training were paid by the company. Under such conditions, engineers of exceptionally high qualifications cheerfully accepted our offers.

COURSES GIVEN AT CALTECH

The schedule consisted of eight weeks' training at California Institute of Technology, followed by eight weeks' instruction directed by the staff of the Lockheed-Vega Education Service.

The first portion of the program was completed on Sept. 20, 1940; during that time five courses of study were given at the California Institute of Technology. The first of these, aerodynamics of the airplane, was given with the assumption that the trainees were totally ignorant of the subject. Consequently, no one had any great difficulty following the course. All involved derivations of formulas were eliminated and the mathematics kept as simple as possible. To bring out practical application of the theories promulgated, problems given were based on the specifications of one of our current-model commercial aircraft. The course consisted of 40 one-hour lectures supplemented by notes published by the California Institute of Technology faculty.

The second of these courses was aircraft materials and standards. While descriptive in nature, this course was given with considerable thoroughness. The lectures were augmented with numerous slides, photographs, trade catalogs, and samples. The Lockheed company furnished various castings, forgings, extruded sections, welded parts, rivet and spot-weld samples, photographs of equipment, and other such items. The course consisted of 25 one-hour lectures with published notes.

The third course was the airplane and its components. It consisted of a general description of the various parts of a modern airplane and their nomenclature. The course, given informally, consisted of 15 one-hour lectures including general discussions. The smaller details were omitted in order that the whole airplane could be covered in the allotted time. Service manuals, blueprints, photographs, and similar material were furnished by the company.

The fourth course, airplane structures and stress analysis, began with the stresses and structures of the whole airplane. As long as it continued general in nature the men had little difficulty with the mathematics involved. However, when the detailed stress-analysis portion of the course was entered into, about half the trainees experienced considerable difficulty in keeping up with the subject matter. This difficulty was caused by some of the trainees not having the required knowledge of mechanics and strength of materials.

This disparity of technical knowledge was not necessarily due to any difference in the abilities of the trainees. The fact that some of the men had been out of school for as long as ten to fifteen years, while others had graduated only a few years previously, was a strong contributing factor to this situation. To alleviate the difficulty occasioned by this variance in background, a test was given to determine which of the men needed the preliminary training. From the results of this test and some individual consultation, sufficient data were obtained for dividing the group into two classes; one class to continue with stress analysis, the other to concentrate their efforts on mechanics and strength of materials. The time allotted for this course was also 40 one-hour lectures. This included both the course as originally outlined and the subsequent divided classes. Published notes were furnished by the California Institute of Technology faculty.

The fifth course consisted of drafting for three hours daily during the afternoon for the eight-week period. The first several weeks were devoted to a review of academic descriptive geometry. One week was spent on technical sketching. The remainder of the time was devoted to drawing and designing detail aircraft parts. The Lockheed engineer assigned to supervising the trainees was invested with the responsibility of interpreting the company standards and conventions involved in this course.

PRACTICAL TRAINING AT LOCKHEED FACTORY

At the completion of the training at the California Institute of Technology, the second or practical phase of the training was begun at the Lockheed factory. At this time, an additional group from the Massachusetts Institute of Technology, comprising 21 men, was added to the group from California Institute of Technology. These men from Massachusetts Institute of Technology were also graduate engineers who have majored in fields other than the aeronautical. However, for the most part, they were fairly recent graduates and did not have any extensive practical experience. Their training at M.I.T. was of ten weeks' duration and consisted of the standard academic aeronautics course.

The program at Lockheed consisted of four one-hour lectures daily in the forenoon. These lectures were given by outstanding engineers who were considered the top men or authorities in their particular field. The lectures were of a practical nature,

being more concerned with practical applications rather than involved theories. Among the courses given were sheet-metal fabrication, assembly methods, applied stress analysis, aircraft mechanisms, lofting, aircraft power-plant installation, wing design, fuselage design, castings and forgings, aircraft electrical design, and aircraft hydraulic systems. In addition, engineers outside the Lockheed organization who are connected with firms manufacturing supplies and accessories for aircraft were brought in for special lectures.

During the afternoon, the training consisted of actual design problems on the drafting board for a period of four weeks; liaison or contact work between engineers and the shop for two weeks; engineering checking of assembly and detail drawings for one week; and tool design and tool planning for one week.

The program at the factory was intended to bridge the gap existing between the theoretical knowledge obtained and the actual application of that knowledge. Thus the transition from student to producing aeronautical engineer was accomplished with a minimum of waste effort.

The present emergency presents an unusual situation and unusual methods have been employed to meet it. No hard and fast program could be devised for all contingencies. As has been shown, college graduates, fresh out of school, present an entirely different problem from the college man who has been in industry for several years. Both these types of men can still further complicate the problem of further training by having some experience, very little experience, or no experience at all in the field for which they are being trained. With all these factors in mind, we have attempted so to conduct our training as to meet most effectively the various needs of these men.

In closing, it might be worth while to point out that institutions of higher learning, which are training engineers for industry, could help the present situation by revising their curricula along more practical lines. This possibility was suggested to us by the difference in the knowledge and ability of groups trained at Caltech and M.I.T. In the former, there was close cooperation between our organization and the university. Our Education Service and the engineer assigned to supervise the training kept in constant touch with the progress of the courses, making suggestions and furnishing material to bring the courses to a more practical level. The M.I.T. program, on the other hand, was not conducted in conjunction with any manufacturer. As a result, the material was more academic and theoretical, thus accounting for the discrepancy between the two groups.

The conclusion, therefore, is that the more practical the training for college men, especially on the higher levels, the more valuable it will be to the men themselves, to the industry in which they are to work, and to our national defense for which the demand is urgent and immediate.

V—The New York State Education Department's National-Defense Training Program at Rensselaer Polytechnic Institute

By WILLIAM OTIS HOTCHKISS[4] AND STANLEY B. WILTSE[5]

RENSSELAER POLYTECHNIC INSTITUTE

DURING the latter part of June, 1940, the Congress passed, and the President signed, Appropriation Bill HR 10104, providing $15,000,000 for the training of industrial workers for occupations essential to the national defense.

The funds appropriated have been allocated through the U. S. Office of Education to the education departments of the various states for the setting up of state programs.

State programs are administered and supervised by the state bureaus of industrial education. They are conducted in the vocational high schools and to a much more limited extent in approved technical schools and colleges.

Courses are of two types:

A Supplementary courses for those persons employed in jobs essential to the national-defense program for the purpose of improving their skill and knowledge.

B Pre-employment refresher courses for workers selected from the public employment registers, who by the training will become qualified for employment in jobs essential to the national-defense program.

There is no tuition charge for any of these courses.

Students who satisfactorily complete courses are given a vocational training card issued by the U. S. Office of Education certifying that they have completed such courses.

The U. S. Office of Education has defined the types of industries which are at present considered essential to the training of defense workers.

Troy is happily situated with respect to a rather densely populated industrial area. It was estimated that such a program located at Troy would serve a population of some 600,000 residents. The two most important defense industries represented in the district are probably the U. S. Government Arsenal at Watervliet and General Electric Company at Schenectady. Other representative defense industries located within the district are American Locomotive Company, the Delaware and Hudson Railroad Shops, the West Albany Shops of the New York Central Railroad, Allegheny Ludlum Steel Corp., Cohoes Rolling Mill Co., The Rail Joint Co., Consolidated Car Heating Co., Behr-Manning Corp., W. and L. E. Gurley Co., Marshall-Eclipse Division of Bendix Aviation Corp., Simmons Machine Tool Corp., and such textile industries as Cluett-Peabody and Co., Inc., F. C. Huyck and Sons, Albany Felt Co., Fuld and Hatch Knitting Co., and Faith Mills, Inc.

PRELIMINARY CANVASS OF LOCAL INDUSTRIES CONDUCTED

Before offering the facilities of Rensselaer Polytechnic Institute to the government it was considered advisable by the administration and the faculty to conduct a preliminary canvass of the most important industries of the district in order to obtain their reactions to the establishment of such a training program. Without exception industry was most enthusiastic and offered its fullest cooperation.

Since the courses to be offered were all of the supplementary type, intended primarily for people already employed in defense industries, it was considered essential to offer the work as an evening program. A further important consideration was that an evening program would interfere in no way with the regular day-time college program.

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It was also considered advisable in so far as possible to use instructors from industry rather than to increase the burden of the regular college staff in a period when many additional demands would be made on its time. The evening program made such a scheme practicable.

The establishment of the program at Rensselaer was given final approval by the State Education Department on July 22, and it was decided to start classes on Aug. 6, 1940.

It should be pointed out that except for the fact that the program makes use of the facilities of Rensselaer Polytechnic Institute, the school is an independent organization operated by the State Education Department.

A descriptive brochure containing general information about the program and brief descriptions of the courses to be offered was prepared and distributed throughout the area.

REGISTRATIONS EXCEEDED EXPECTATIONS

Registrations for courses were scheduled on different evenings, two at Troy, one at Albany, and one at Schenectady. Applicants were to be enrolled after personal interviews to determine eligibility on the bases of education, industrial experience, and acceptability on defense grounds.

Maynard M. Boring, engineering general department, General Electric Company, and John H. Leadley, a retired industrialist and alumnus of Rensselaer Polytechnic Institute, both of whom have had a great deal of experience in personnel work, volunteered to assist in the interviewing of applicants. Their offers were gratefully accepted. Both devoted full time on the four registration nights to personal interviews.

It was anticipated that the maximum number of applicants on a given night might be of the order of 100 and that Mr. Boring, Mr. Leadley, and Professor Wiltse would be able to handle all of the interviews. It developed that on the first interview night a crowd of over 500 applicants appeared—far more than it was possible for the interviewers to take care of, even though interviews were conducted from 7:30 p.m. until 12:30 a.m.

On subsequent registration nights the interviewing staff was augmented by members of the Institute staff and members of the personnel staff of General Electric Company. Similar crowds of applicants were encountered on all four registration nights.

Since several interviewers were working simultaneously it was not feasible to keep a running record of the numbers of applicants tentatively accepted in individual courses. It was furthermore not considered possible for the interviewers to completely judge and evaluate the educational qualifications of applicants for such a wide variety of technical courses.

Many industrial executives voluntarily cooperated by conducting preliminary interviews of interested employees, culling out those who were obviously not qualified and giving letters of recommendation to those whom they considered eligible.

At the close of registration some 950 applications had been tentatively approved and at least an equal number disapproved.

On the first evening of classes the entire tentatively approved group was assembled and it was announced that final selection of enrollees would be made by the instructors in the various courses.

In this way enrollees were reduced to 740, the number which instructional facilities would permit.

INSTRUCTORS RECRUITED FROM INDUSTRY

In selecting an instructional staff the various local industries were canvassed to obtain qualified experts who would be willing to undertake the job of instruction. The response was most gratifying. Many who volunteered their services were men now occupying executive positions, who have had many years of experience in industry. The general feeling expressed was that the program was worth while and demanded their fullest cooperation.

Since the courses offered are for the most part technical, it is only natural that many of the instructors chosen were from General Electric Company with its great reservoir of technical talent. Other sources from which instructors have been selected are Cluett-Peabody and Company, Inc., Bendix Aviation Corporation, Behr-Manning Corporation, Watervliet Arsenal, U. S. Social Security Office, U. S. Weather Bureau, and New York State Department of Public Works. During the early part of the program a few of the regular Institute faculty were employed until they could be replaced with satisfactory instructors from industry.

WHAT SUBJECTS ARE TAUGHT

At present courses in twenty-five subjects are being conducted. The subjects are:

	Total hours
Principles of metallurgy	100
Scientific bases of welding	100
Elementary machine design	100
Elementary tool design	100
Power generation, mechanical equipment	100
Advanced manufacture and production	100
Reading of maps and aerial photographs	100
Optics and optical instruments	125
Photography	125
Spectroscopy	125
X-ray technique	125
Drafting and drafting-room practice	125
Elementary engineering electronics	100
Electrical instruments	100
Electrical machinery	100
Strength of materials and testing laboratory	125
Structural engineering	100
Foremanship and supervision	100
Office management and operation	100
Manufacturing costs	100
Statistical methods in industrial control	100
Differential equations	100
Exterior ballistics	100
Mathematics for machinists	100
Elementary meteorology	100

Classes meet on Tuesday and Thursday evenings at 7:30 and extend over a 2 hour or a $2^1/_2$ hour period depending on the course. Present courses are scheduled to extend over a period of 25 weeks, giving a total course duration of 100 or 125 hours.

A good example of a typical course "setup" is that for the course in drafting and drafting-room practice. The instructors are the assistant supervisor of drawings for General Electric Company, an instructor in the General Electric Company "vestibule" drafting courses, and the supervisor of apprentice draftsmen at Watervliet Arsenal.

Other courses are similarly set up to be of a distinctly practical nature.

NUMBER AND QUALITY OF THE ENROLLED STUDENTS

In scanning the registration of students one cannot help but be impressed by the excellent qualifications and the seriousness of purpose of the group. Many of the enrollees are executives in defense industries and all enrollees are amply qualified to pursue the courses intelligently.

Thirty-nine towns and cities of the area are represented among the enrollees. There are 270 enrollees from Troy, 128 from Albany, 120 from Schenectady, 97 from Watervliet, and 30 from Cohoes.

Representatives of 13 industrial firms make up 65 per cent of the total registration.

Twenty-six per cent of the total registration is from Watervliet Arsenal and 10 per cent from General Electric Company.

There are 32 women students enrolled in the defense courses. In age they range from 20 years to 48 years. Many are graduates of well-known colleges and a few have pursued graduate study. Although most are enrolled in business courses there are some enrolled in such courses as machine design, engineering electronics, drafting, spectroscopy, X-ray technique, differential equations, and exterior ballistics.

Male enrollees vary in age from 20 years to 55 years with a corresponding variation in experience. In occupations they vary from apprentices to officials and executives.

Enrollees have been asked to furnish case histories with brief statements of their reasons for enrolling in courses. Excerpts from a few of the more interesting replies follow:

A student in the course in mathematics for machinists writes:

My idea of taking this course is to gain a more thorough education in mathematics so that if ever the opportunity of getting a better position presents itself, I will be better equipped as a man for the job. Also in my trade as a tool, jig, and fixture man you need a good training in mathematics. Without this training you can go only so far. That is, a man with only the practical experience is always depending on someone else for the mathematical end of the job.

A student in the course in elementary machine design writes:

I graduated from high school in 1935. Two years later I went to — — Extension for a three-year course in mechanical engineering, with the intention of going to — — College to complete my course. In the second year of night school my father died. My plans were changed. I finished the course and had to support my widowed mother. I enrolled in the government R.P.I. course to help me in my present job at the General Electric Company. I am working in the Industrial Control Building doing Government work. I attended the General Electric course in drafting.

A student in the course in principles of metallurgy writes:

I have been employed at the Allegheny Ludlum Steel Corporation plant as assistant chief inspector for the last 13 months. At this position I have had a chance to receive a fair knowledge of melting, rolling, heat-treating, finishing and inspection of steel—also some testing such as deep etch, grind down, tensile, Brinell, Rockwell, etc.

My objective is to further my education in the subject of metallurgy so I will be better able to fill my job. By a better knowledge of this subject I will be better able to do my work. In so doing I may be able to increase my production capacity as well as help to constantly improve methods and quality of work and product.

A student in drafting and drafting-room practice writes:

A knowledge of drafting will help me in my present job. I feel that it will broaden my knowledge and make me better equipped to meet my present position. Since my firm is doing a great deal of government work at present, more responsibility is required on my part. Therefore I feel that by gaining a greater knowledge of this subject I will become more valuable to my employer.

As the program has progressed the enthusiasm of both instructors and students has continued undiminished. Instructors report students eager to learn and keenly interested in the courses.

It must be remembered that there is nothing to influence these students to continue the work except their own interest in what they are getting out of the classes and their conviction of its value to them. Despite this lack of any other hold on them, there have been comparatively few withdrawals from courses. Some enrollees have been transferred to jobs in other localities. Some have been transferred from day shifts to night shifts. A few have been dropped because of inadequate preparatory training.

CONCLUSIONS FROM EXPERIENCES

In the light of the experience gained with the present program the following conclusions have been drawn:

1 Courses of the supplementary type should be given preferably in the early evening hours, two or three evenings per week.

(*a*) Such courses interfere least with regular daytime college programs.

(*b*) Day-time employees in defense industries can attend the courses without interference with their regular work.

(*c*) They permit the employment of well-qualified instructors from industry who would not be available during the day.

2 There is a definite need for such programs in industrial areas. This is evidenced by the enthusiastic response to the program by both management and personnel of defense industries.

3 Careful initial selection of enrollees will avoid heavy casualty lists as the courses progress. It is believed that the combination of a carefully thought out application blank with a personal interview is much more satisfactory than the application blank alone and that the additional time and effort involved in the personal interview is well worth while.

Cushing, N. Y.

EMERGENCY DEFENSE TRAINING—A CLASS IN PATTERN MAKING

Photo by U. S. Army Signal Corps

TANKS WITH RUBBER TREADS—LINE-UP AT ARMY MANEUVERS

ADVANCES *in* RUBBER *and* PLASTICS DURING 1940

By F. L. YERZLEY[1] AND G. M. KLINE[2]

UNTIL recently rubber and plastics have been somewhat foreign to the experience of mechanical engineers. The increasing trend toward the structural application of these materials, however, has opened new vistas to those engineers who have been in a position to keep in contact with them. To those who have not been so fortunate, the conflicting views on design and contradictory interpretation of results have sometimes been confusing and discouraging. It is not possible to eliminate completely the unexpected difficulties that frequently accompany the applications of new materials, but the prospect of tremendous strides in design and production together with the related prospect of reduction in costs and expansion of markets easily offsets the difficulties, usually temporary, which accompany such progress. Yet in each year there stands above cases of discouragement and failure a distinct trend of progress in design and in thought which strikes the keynote for the year to come.

The Subdivision on Rubber and Plastics of The American Society of Mechanical Engineers attempts in this report to summarize events of the year 1940 for mechanical engineers, and thus to give expression to the trends for 1941.

The Subdivision on Rubber and Plastics of the A.S.M.E. is dedicated to the service and fellowship of engineers concerned with the mechanical problems of producing or using rubber or plastics. At the outset rubber and plastics were grouped together in one organization in recognition of certain similarities during processing, and the quite definite promise that as new materials were synthesized, the gap between materials now considered rubber-like and those commonly classed as plastics would gradually be closed. That the distinction between plastics and rubber is not clear-cut has been commercially illustrated during the last year by the use of polyvinyl resins for such personal wear as suspenders and watch bands. Rubber companies have expanded their interest in plastics and further expansion has been urged (1).[3] For clarity in presentation, rubber and plastics will be independently considered in this report.

RUBBER

Normal progress has been disturbed by the concentration on national defense. The question of supply has, of course, received major attention. Normal economy would not support huge synthetic-rubber industries in the present state of development. Hence, expenditure of huge sums for such plants can only be justified on the basis of strategic necessity as stand-by plants (2) in the event of interruption of natural supply. If storage of an adequate supply of natural rubber can be accomplished, this should be done to avoid economic waste. Furthermore, although much can be accomplished, if need be, toward synthesizing all of our rubber it does not appear to our advantage from a long-view standpoint to do so. In addition to the adverse economic prospect we stand to lose technically by limiting the types of synthetic rubber to those that could be produced in the plants that would be built today. Rather than as a replacement for natural rubber, the field for synthetic materials seems to be properly in those applications which are gradually developing to employ most effectively the unique characteristics of each entirely new class of materials. Whatever the outcome may be, the problem has been studied intensively for some time (3, 4, 5) and the final decision may be based upon the turn of events beyond our control.

Prepared as a report of the Subdivision on Rubber and Plastics, of the Process Industries Division of The American Society of Mechanical Engineers with the cooperation of W. F. Busse, E. G. Kirmich, C. M. Sloman, O. M. Hayden, L. E. Jermy, J. F. D. Smith, H. W. Paine, W. A. Zinzow, and W. F. Bartoe.

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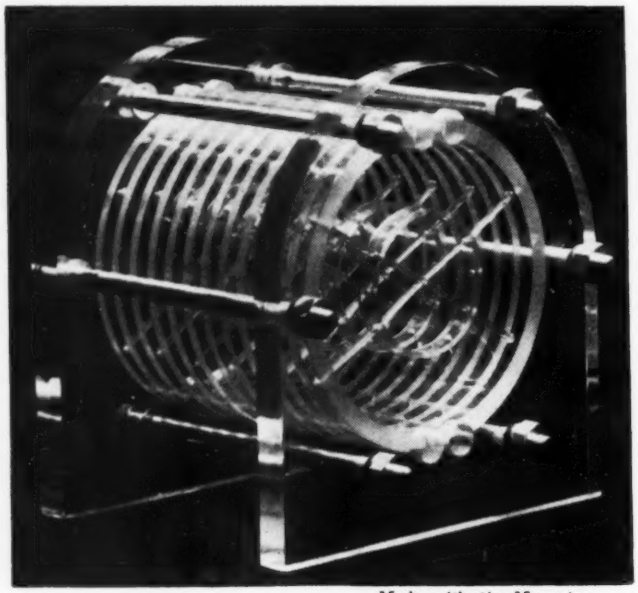
[3] Numbers in parentheses refer to Bibliography at end of paper.



Modern Plastics Magazine

LABORATORY UNIT COMPLETELY CONSTRUCTED OF TRANSPARENT ACRYLIC MATERIAL HIDES NOTHING FROM THE OBSERVER

During the last year there has been a distinct increase in the number of applications of rubber and rubber-like materials in mechanical equipment. In automobiles alone, the number of rubber parts in the 1941 models approximately doubled that in models of the previous year. Not only has the number of parts increased, but intense activity has led to the refinement of parts already accepted. These refinements have sought further economies in production, as well as improvement in operating characteristics and life. As a portent of new developments to come, Chrysler has built a new laboratory for rubber and plastics (6) and other laboratories have expanded their facilities for mechanical studies.

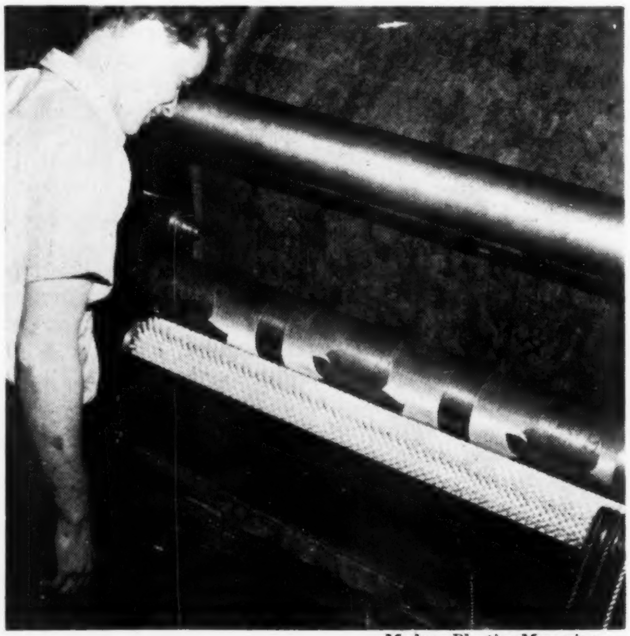
Much of the growing use of rubber is due to further refinements of high-speed machinery, in which vibration problems present a unique opportunity to employ the elastic qualities of rubber. Many examples exist in harmonic balancers on shafts, mountings of various types for machinery, both large and small, flexible couplings on shafts, and insulating bushings surrounding bearings. In many cases applications which would have been impossible a few years ago are accepted practice today as the result of the development and the refinement of synthetic materials.

The application of rubber has increased the desire of professional organizations to disseminate information on its properties. Several outstanding contributions have been made during the last year. Some of these have been concerned with narrowing the region of controversy over the effect of shape upon the over-all stiffness of rubber springs (7, 8). Others have dealt with the part rubber plays in the isolation of vibration and the more complete evaluation of transmissibility characteristics (9). A feature related to this problem has been the effect of fatigue upon the life of the spring and substantial contributions in this field have been made (10). A further field which has been the subject of intense attention and exploitation is the use of combined types of loading in mountings employing various degrees of compression, extension, and shear (11). The possibilities of investigation are almost unlimited both because of the unlimited variations that may be made in the shape of springs and because of the extensive control available over the mechanical constants of the material itself.

In the general problem of designing elastic supports there is as yet no entirely satisfactory standard method of evaluating properties. Among the shapes proposed for standard evaluation are a unit cube, a cylinder $^3/_4$ in. in diameter and $^1/_2$ in. high, a cylinder 1 sq in. in cross section and 1 in. high. For reasons of symmetry it is possible that the cylindrical form should be preferred but it may be premature to adopt any particular shape or size until much more work has been accomplished. It is to be hoped that theory may eventually provide a satisfactory method of comparison independent of shape. A distinct contribution was made during the year to the theory of large elastic deformation (12).

In certain quarters the demand has continued, although in somewhat decreased volume, for the specification of rubber-like compositions in terms of chemical content. Although this method of specification is the easiest from the standpoint of those who prepare compositions, it offers no promise as a means of acceptance testing, except for rather broad classifications of chemical content. This method of specification breaks down completely due to the complicated chemical changes that occur during both vulcanization and testing. Furthermore, there is no unique correspondence between chemical composition and mechanical properties. Rather it appears more promising to establish as the result of concerted effort a series of mechanical tests and aging tests from which materials can be properly identified as belonging to specific mechanical groups. The efforts of the American Society for Testing Materials in this direction have been extremely important.

This report on rubber would be incomplete without calling attention to certain important references. It is unfortunate that much of the work that has been done has gone unnoticed by engineers, yet each of these key references on standard methods of testing and a related bibliography (13), on sources of supply of rubber goods (14), on the recent bibliography of rubber publications (15), on the American rubber industry (16), on synthetic rubber (17), and on progress in rubber chemistry (18) should be available to every engineer. In closing it should be emphasized that the development of rubber is dynamic, and that many applications that are not practical today may become eminently practical in the very near future as new materials and knowledge are developed by current research.

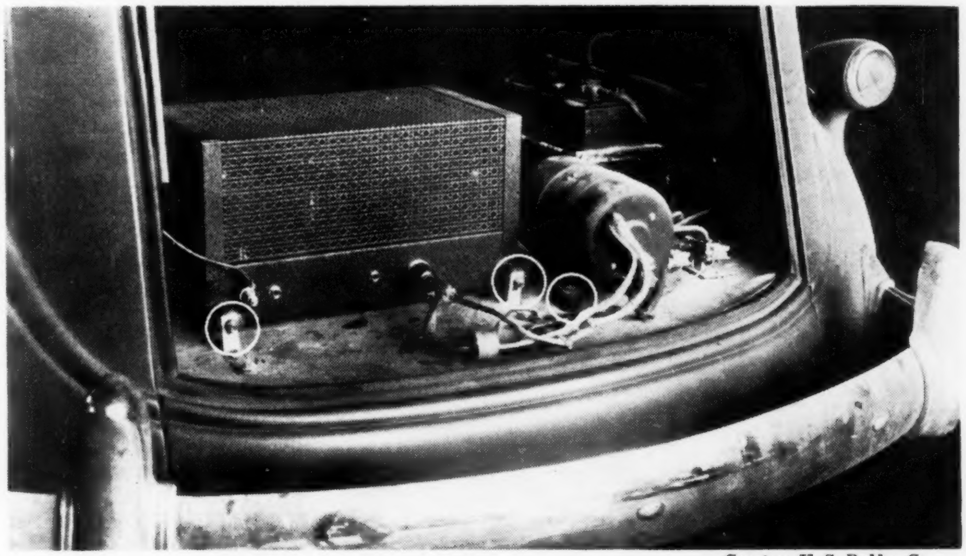


Modern Plastics Magazine

BEHIND THE SCENES IN THE TEXTILE-PRINTING INDUSTRY, FURNISHER BRUSHES BRISTLE WITH SYNTHETIC ORGANIC PLASTICS

PLASTICS

A trend of vast purport has been toward the utilization of plastics by the armed forces of every major nation (19, 20). Military applications, definite and potential, include laminated materials in airplane construction, streamline-formed transparent fuselage and wing sections, cast resins in guide lines on airplane carriers, luminescent resins in various military devices, tinted cellulose-acetate windows for air-raid protection, gunstocks of cellulose acetate and fabric-filled phenolic resins, cellulose-acetate chutes for conveying ammunition belts from boxes to machine guns in airplanes, phenolic mouthpieces and containers for gas masks, impregnation of the fabric of gas masks for civilian use with vinyl-chloride resin as a protection against mustard gas, transparent plastics in soldiers' goggles, phenolic noses of antiaircraft shells, and the possible application of nylon as a parachute material. In three British fighting services the uses of synthetic resins are said to exceed 1000 in number. A survey of plastics in the United States defense economy indicated that all types were amply available and that the molding and laminating plants were capable of handling extensive increases in production demands (21).



Courtesy U. S. Rubber Co.

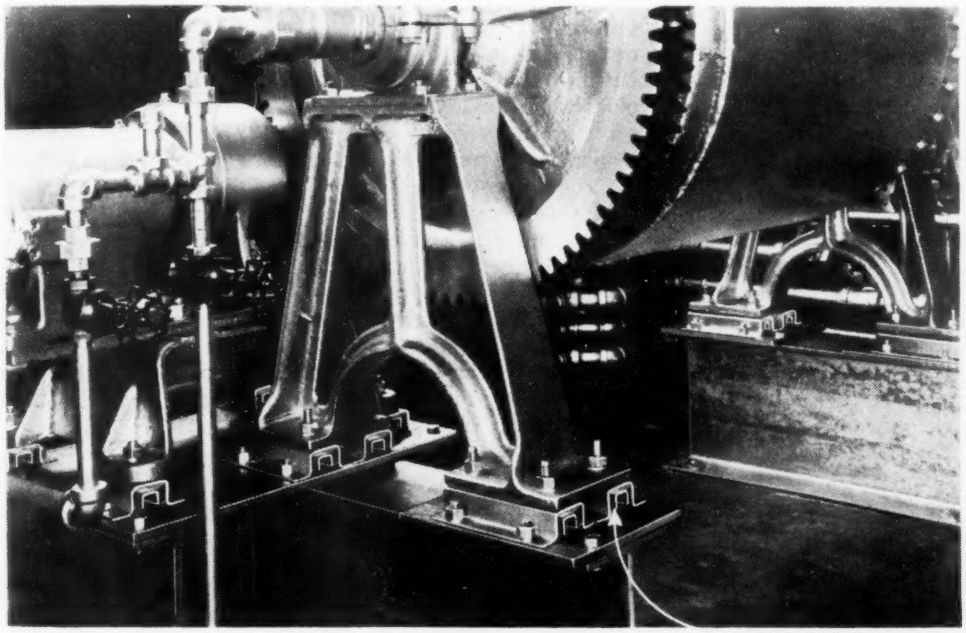
EFFECTIVE OPERATION OF RADIO EQUIPMENT IN POLICE CAR DEPENDS ON RUBBER MOUNTINGS

(Tubes were continually being broken and there was much unnecessary noise until four rubber mountings were installed under transmitter, generator, and battery.)

Another item of general interest is the recommendation in British regulations for the electrical equipment of buildings that electrical apparatus of the all-insulated type be installed wherever practicable and that the use of electrical apparatus (particularly electric toasters and hair driers) having exposed metal parts be avoided as far as possible. Lamp holders, so constructed of, or so shrouded within, insulating material that it is impossible to touch any metal part, were also recommended. The availability of plastics for the construction of all-insulated equipment, particularly molded housings, is said to have prompted this recommendation (22).

No really new plastics appeared on the market during 1940, but outstanding progress in developing increased volume through new markets can be credited especially to the vinyl-ester resins, cellulose acetate butyrate, and cellulose-acetate molding powder. These materials took many of the awards in the Fifth Annual Modern Plastics Competition (23). Vinylidene chloride resin is commanding attention in its applications as high-strength fibers and seat coverings (24). Nylon resin is entering the industrial field as bristles for brushes (25). Other high lights of the year in materials development include the production of plastics from cellulose acetate of higher acetyl content (58 per cent acetic acid) than previously employed (26), and the further activity in the manufacturing of melamine resin (27). Investigations pertaining to the use of farm waste products for the production of plastics were reported on by the Agricultural By-Products Laboratory, Ames, Iowa (28), and by the University of Tennessee Research Corporation (29).

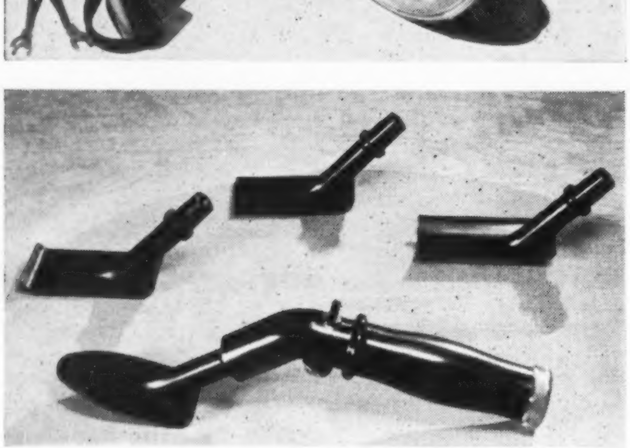
Improvements in injection



Courtesy U. S. Rubber Co.

TWELVE RUBBER MOUNTINGS SOLVED THE PROBLEM

(Vibration, resulting from the rotating machinery of this 1800-lb ball mill traveled so vigorously through a building that complaints were voiced four floors below. Rubber mountings were the answer.)



Modern Plastics Magazine

ABOVE: PORTABLE SEARCHLIGHT MADE OF CELLULOSE ACETATE
BELOW: MOLDED PHENOLIC-PLASTIC PADDLES USED IN THE AUTOMOTIVE INDUSTRY FOR SPREADING BODY SOLDER

and compression molding presses have been concerned primarily with various operating features, particularly heating (30) and automatic controls (31). The technique of continuously extruding thermoplastic materials has also advanced considerably during the last year (32), and extruded plastics are replacing reed and rattan in woven furniture (33). A process for forming molds by spraying metal against a model has been perfected to the point where production molds have been made and are being tested in service (34).

The aircraft industry has, of course, been spotlighted during the past year, and further important strides were made in the use of plastic plywood for molding airplane wings and fuselages (35). An outstanding development in this field was the laminated plastic tab for insertion in ailerons, elevators, and rudders to aid in balancing and controlling the airplane during flight (36). The reinforced plastic contributes a saving in weight and greater rigidity in these parts. Many new applications of black cellulose-acetate plastic in unstressed and slightly stressed parts on aircraft were reported in England (37).

Resin-bonded plywood is expanding into many industrial fields. Refrigerator cars constructed largely of this material are said to be 6000 lb lighter than the previously used type and to provide a considerable economy in fabrication costs because of an 86.5 per cent reduction in the number of joints and a 19 per cent reduction in fastening elements (38). Simplification of small-boat construction and improved weather resistance of decking and planking for larger craft have also marked the introduction of this material into the shipbuilding industry (39).

The use of laminated plastic for bearings (40) and cams (41) in high-speed industrial machinery was further extended during the last year. Jigs and fixtures used for light milling operations made of laminated plastic represent a new development (42). Laminated plastic sheets, rods, bars, and tubes made in various cross sections and lengths are available so that these tools can be produced with very little machining.

Many branches of industry which had previously made extensive use of plastics added new molded parts to their products. Summaries of developments in the automotive (43), radio (44), refrigerator (45), and mechanical-handling fields (46) were published. Other industrial items which merit particular mention are a bilge pump with corrosion-resistant phenolic housing (47), a motor analyzer consisting of 18 precision-molded parts (48), and a 5-pole, panel-type magnetic switch with molded phenolic shaft and cold-molded plastic arc chute (49).

The two papers relating to time and temperature effects on the tensile and compressive strengths of thermoplastics (50) and on the creep and cold-flow characteristics of thermosetting and thermoplastic materials (51), which were presented before this Subdivision a year ago, were among the outstanding contributions to our knowledge of the mechanical properties of plastics published during the last 12 months. The important physical properties and performances of plastic bearing materials were surveyed in another paper originally presented before a division of The American Society of Mechanical Engineers at the 1939 Annual Meeting and published during 1940 (52).

The effects of prolonged exposure at elevated temperatures on the tensile strength, hardness, water absorption, weight, and dimensions of phenolic laminates were investigated and recommendations submitted for the maximum temperatures to which these materials should be subjected in continuous duty (53).

In an investigation (54) of resin-impregnated compressed plywood prepared at pressures up to 1500 psi compressive strength was found to increase in direct proportion to specific gravity and the tensile strength varied approximately in proportion to the 1.25 power of the specific gravity. Thus veneers of $^1/_{48}$ in. thickness gave stronger bonds than veneers of $^1/_8$ in. thickness. Other variables such as species of wood, amount of resin, number of cross layers, and pressures from 200 to 1500 psi were investigated.

Tentative standard methods were adopted by the American Society for Testing Materials for measuring flammability of plastics, flow temperatures of thermoplastic molding materials, and absorption of water by plastics (55). Three papers pertaining to plastics were presented at the June, 1940, meeting of the A.S.T.M. One of these described an accelerated weathering test for plastics which gives results correlating well with those observed in outdoor exposures (56). The second paper was concerned with the amount of moisture absorbed and desorbed by plastics for periods up to two years and the effect of various test conditions on the value observed for water absorption in short-time tests (57). The third paper related to the measurement of the plasticity of molding compounds by means of a 2.5-in. disk mold with capillaries extending downward from the disk (58). Another paper resulting from the activities of this A.S.T.M. Committee reported experiments made in measuring the flow temperatures of thermoplastics with the Rossi-Peakes flow tester and three plastometers (59). This work culminated in the tentative standard method for measuring flow temperatures of thermoplastic molding materials.

A paper published early in the year presented the results of a study of the bursting strength of laminated glasses made with cellulose acetate and acrylic and vinyl resins (60). This property is of importance in connection with pressure cabins in aircraft for substratosphere flying. All types of laminated glass were found to have higher burst pressures at temperatures near —30 C than at about 20 C. Some specimens under constant pressure fractured after a few minutes at a pressure one third of that necessary in burst tests conducted under regularly increasing pressures. The former test is considered more significant in so far as actual use in aircraft is concerned.

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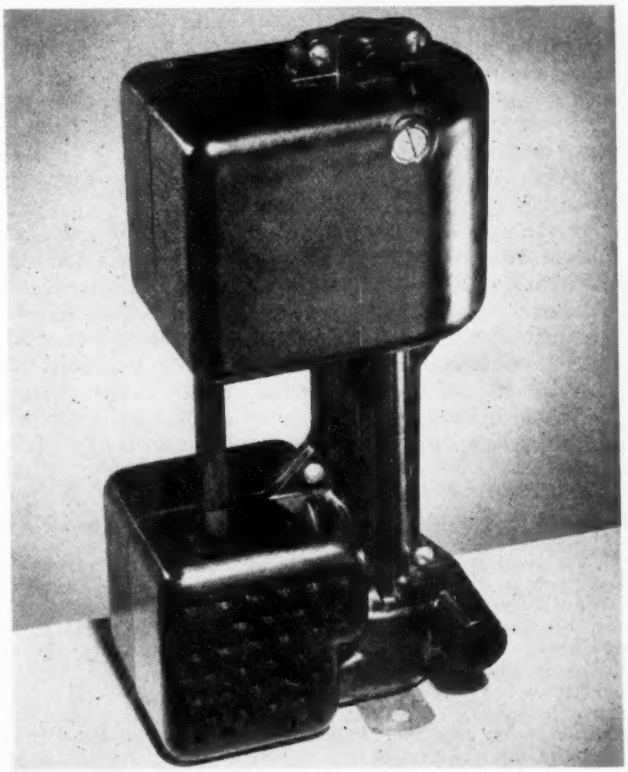

ELECTRIC BILGE PUMP WITH MOLDED PLASTIC CASING, SCREEN, PIPING, AND IMPELLER, WINS PRIZE IN TRANSPORT GROUP OF FIFTH ANNUAL MODERN PLASTICS COMPETITION

A.S.M.E. COMMITTEE *on* RESEARCH[1]

A Statement of Its Functions and Procedures

IT IS definitely established by the Charter, Constitution, and By-Laws of The American Society of Mechanical Engineers that it is authorized to engage in research. The authorization is broad in its provisions. The Standing Committee on Research is also appropriately authorized to function as an agent of the Council of the Society.

FUNCTIONAL PATTERN

The functional pattern of the Society may be construed as including four basic parts, namely:

1 The accumulation and dissemination of knowledge.

2 The development of skill in the interpretation and application of knowledge.

3 The encouraging of mechanical engineers to discharge their professional and social responsibilities.

4 The elevation of the intellectual, economic, professional, and social status of the engineer and the engineering profession.

These functions are discharged through the activities of professional divisions, local sections, standing and special committees, and through the meetings and publications of the Society.

The professional divisions now cover five fields of interest, namely: Basic sciences, management, power, transportation, and manufacturing.

The professional divisions provide a ready means for obtaining information on the state of the sciences and arts within the field of activity of mechanical engineers. By these divisions maintaining a keen awareness of the need for research and by cooperating actively with the Standing Committee on Research, the Society can become a very forceful factor in research. To this most desirable end this report provides a larger place than heretofore for the professional divisions in the research activities of the Society.

DEFINITION OF RESEARCH

For the purposes of this report the definition of research as given in the unabridged Standard Dictionary is accepted. The definition is—"Research is an organized, diligent investigation to discover facts." Under this definition the Society may participate in research of wide scope and character. However, the Society should confine its research activities to those lines which are directed toward extending the boundaries of human knowledge and which are not in any specific sense concerned with the development or improvement of commercial products.

DUTIES OF STANDING COMMITTEE ON RESEARCH

The major duties of the Standing Committee on Research are as outlined below. These are to be carried out in cooperation with the Professional Divisions or other groups.

1 To select, initiate, and, through appropriate special research committees, supervise the execution of research projects. The Standing Committee on Research may, however, upon its own volition, initiate and execute research projects in those cases where the circumstances pertaining to any professional division warrant such action, and also in such cases as may not come within the purview of any existing professional division.

2 To evaluate critically, each year, all projects on the research docket to determine those projects which should be discontinued, postponed, or expedited. Those projects retained on the docket are to be rated in the order of importance and timeliness.

3 To assist the professional divisions and other groups in the organization of special research committees.

4 To approve the personnel of special research committees.

5 To exercise control over all expenditures for research.

6 To establish time schedules for progress reports and the approximate date for the completion of each research project.

7 To approve, before any effort is made to obtain funds, the plan for financing each research project for which the Society assumes any moral, professional, or financial responsibility.

8 To coordinate the research programs of two or more professional divisions or other groups concerned with a given project.

9 To encourage research in technical institutions by, for example, submitting each year lists of desirable research subjects, including subjects appropriate for theses.

10 To classify each research project, when first considered, in accordance with the following grouping and to exercise that degree of control specified for each group.

Group *A:* Research projects initiated, financed, and executed under the direct responsibility of the Society. In all such cases the Standing Committee on Research is to supervise and control.

Group *B:* Cooperative programs in which the Society assumes some measure of responsibility for planning, financing, and executing the programs. In such cases the Standing Committee on Research is to supervise and control to the extent of the responsibility of the Society.

Group *C:* Administrative, wherein the Society as a matter of good will and public service merely acts as the custodian and dispenser of research funds. The Standing Committee on Research is to approve such relationships.

Group *D:* Moral support, in which case the Society merely lends moral support and does not assume any responsibility. In such cases however, such sponsorship is to be approved by the Standing Committee on Research.

11 To approve, prior to any actual participation of an official representative of the Society, any representation of the Society on any joint research committees and the persons who may serve.

MEETINGS OF THE COMMITTEE ON RESEARCH

The following recommendations are made with respect to meetings of the Standing Committee on Research:

(*a*) That two business meetings be held per year, and that, consistent with prevailing policy, provisions be made to pay the traveling expenses of the members of the committee.

(*b*) That the semisocial dinner meeting held during the An-

[1] A report of the Standing Committee on Research to the Council of The American Society of Mechanical Engineers. The first and second drafts of this report, in the form of progress reports, were issued May 15 and May 31, 1940, respectively. The progress report of May 31 was submitted to the Council at Milwaukee, Wis., June 16–17, 1940, and was accepted by the Council at that time. It was revised Oct. 7, 1940, and approved by the Council at its meeting of Dec. 6, 1940. The report as here published is the form approved by the Council, except for the omission of the "preamble," a table of projects relating to the National Research Council's survey of research in industry, and a section recommending a slight change in the wording of the Society's By-Laws, which was adopted by the Council on Dec. 2, 1940. The Standing Committee on Research responsible for the report consisted of L. W. Wallace, chairman, E. G. Bailey, M. D. Hersey, W. Trinks, and J. H. Walker.—Editor.

T. BAUMEISTER
Power

EDWARD H. HEMPEL
Management

THOMAS B. DREW
Heat Transfer

ALEXANDER KLEMIN
Aeronautics

LEE SCHNEITTER
Oil and Gas

E. R. KAISER
Fuels

J. ORMONDROYD
Applied Mechanics

ARNOLD WEISSELBERG
Process

Recently Appointed Research Secretaries of A.S.M.E. Professional Divisions

nual Meeting of the Society be continued but not construed as one of the business meetings.

PROFESSIONAL DIVISIONS

The professional divisions are in a better position than any other group to determine regularly the lines of research needed in their respective fields. In anticipation of closer cooperation between the professional divisions and the Standing Committee on Research and in the interest of enlarging and increasing the effectiveness of the Society in the field of research, the following recommendations are submitted:

1 That the chairman of each professional division, with the advice and consent of the executive committee thereof, appoint each year an official research secretary to serve as the liaison officer between the division and the Standing Committee on Research.[2]

Among the duties of the research secretary, under the direction of the Executive Committee of the Division, shall be these: (*a*) Stimulate interest in research in the division; (*b*) supervise the research activities of the division; (*c*) keep an up-to-date list of subjects requiring research; (*d*) prepare information required by the Standing Committee on Research; (*e*) aid in the selection of the personnel for special research committees.

2 That each research secretary, with the advice and consent of the Executive Committee in each case, prepare and submit annually to the Standing Committee on Research a list of needed research projects classified as shown in paragraph 10 of "Duties of Standing Committee on Research."

3 That after the Standing Committee on Research receives the list referred to, a conference be held between appropriately designated representatives of the committee and the executive committee concerned in each case to select the subjects to be placed upon an approved research docket.

4 That each executive committee, with the aid of its research secretary, prepare a complete plan of action for each approved subject and submit the plan to the Standing Committee on Research for final consideration and approval. The plan of action should include such factors as:

(*a*) A specific statement of the question or problem.
(*b*) A definite statement of reasons for undertaking project.
(*c*) A statement of the objectives to be obtained.
(*d*) Plan of organization for doing the work. This shall include recommendations as to personnel of the special research committee as well as the chairman thereof.

[2] Eight research secretaries of A.S.M.E. Professional Divisions have been appointed to date.

(*e*) A careful estimate of the total cost, including personnel, materials, equipment, travel, and contingencies.

(*f*) The plan for securing the necessary financing.

(*g*) A schedule showing when (1) the work will be started; (2) progress reports will be submitted; and (3) the final report may be expected.

(*h*) Provisions for the submission of progress reports to the chairman of the special research committee in charge of the project and in turn to the Standing Committee on Research. In any event a progress report is to be submitted to the Standing Committee on Research at least once each year in September.

Upon approval of such a plan by the Standing Committee on Research and the Council, the Division may proceed in accord with the provisions of the plan.

5 That each special research committee, in September of each year, shall submit to the Standing Committee on Research a complete financial statement. This statement shall show the total expenditures to date for personnel, materials, equipment, travel, and contingencies for each current project. In addition, it shall show an estimate of the amount which is required to complete the project and the amount of money in hand for such purposes.

FINANCING RESEARCH

The plans presented herein contemplate an increased research activity on the part of the Society. Some measure of increase will be realized without additional expense by virtue of the improved organization and supervision herein provided for. However, the Standing Committee on Research will require more staff assistance than now appears to be available. A study should be made of ways and means of providing larger funds for research. Some additional funds may be obtained, however, by putting into effect a plan approved by the A.S.M.E. Council, Dec. 3, 1934. In substance the action of the council was:

1 It shall be the policy of the Society in raising funds for research purposes to include a reasonable percentage of the total amount raised to cover, in part, administrative expense.

2 The Standing Committee on Research is to advise all Special Research Committees that an addition of 10 per cent shall be added to the estimated cost of each research project and that it (the special research committee) shall advise those approached for funds of this administrative charge.

3 No such percentage is to be added to grants from the Engineering Foundation.

4 Funds so obtained shall be kept separate in the accounting of the Society.

It is believed that a reasonable charge for administrative expense is justified and would not be objected to by most people. Such a charge is common practice with universities and research institutions. They frequently add a percentage of from 20 to 30 per cent of the cost of doing the work. It is recommended that the following charges be adopted:

1 For group *A* projects: an administrative charge of 10 per cent of the fund collected shall be made.

2 For group *B* projects: an administrative charge of 5 per cent of the fund collected shall be made.

3 For group *C* projects: each case to be considered on its merits. If some charge seems to be justified and at the same time it is advisable, then the charge should not be more than to cover actual out-of-pocket expenses or from two to three per cent of the amount of funds handled.

4 For group *D* projects: it is not contemplated that expense would be involved in such cases and consequently no charge would be made.

SURVEY OF RESEARCH IN INDUSTRY

The National Research Council is conducting a study entitled "Survey of Research in Industry." A very able committee is supervising this work. Dr. Harvey N. Davis and Secretary C. E. Davies have prepared a valuable section covering mechanical engineering. In so doing they sent a letter to a number of industrialists and engineers requesting a list of research projects in process and a list of subjects in the field of mechanical engineering which should be subjected to the processes of research. This can be said about the list of subjects suggested:

1 There is some duplication in that a research program for a given subject, if carefully planned, could be made to cover some of the other subjects.

2 Some subjects suggested clearly pertain to product improvement and would not come within the purview of the Society.

3 It is known that some of the subjects, in some regard at least, are now being subjected to research.

4 Many of the subjects are fundamental in character and are of concern to many people.

5 It is clearly evident that a much larger degree of cooperation and coordination than now obtains is most desirable and would be most profitable.

6 It would appear that a series of authoritative and interpretative monographs covering a number of the noncompetitive and nonconfidential subjects is needed and would serve a most useful purpose.

The important thing about the list is that it reflects the judgment of a number of able men engaged in many industries. Moreover, the list is a small sample in terms of the entire field of mechanical engineering. A more complete sample would certainly disclose a much longer list of subjects.

Appreciating the source and importance of the subjects suggested, a careful analysis has been made of them and a list of the subjects coming within the purview of each of a number of the professional divisions is being submitted to each. Each division will be requested to study each subject and to recommend a line of action to the Standing Committee on Research.

FELLOWSHIPS—PUBLICITY

The standing committee on research has given careful consideration to the suggestion that the Society endeavor to secure funds with which to finance fellowships. The value and importance of fellowships are recognized as are the problems associated therewith. The committee is of the opinion that the Society would be well advised to accept and administer any funds tendered for such a purpose. However, it is not prepared to recommend that the Society as a matter of fixed purpose undertake to establish fellowships. This position is predicated on these considerations: That fellowships benefit a very limited number of people; that for the amount of the expenditure, frequently the returns are small and intangible; that the Society should not spend money it receives directly or indirectly from its members for such a purpose; that through other ways and for an equivalent expenditure a much larger number of junior engineers may be equally benefited.

There is no line of activity which commands more popular interest than research. Therefore it would be decidedly in the interest of the Society if more publicity were obtained for its research activities and findings. It is earnestly recommended, therefore, that the Publications Committee give consideration to ways and means of securing a larger measure of publicity for the research activities of the Society. The effort should not be confined to technical publications but made to include popular magazines and the daily press. Ways and means should be provided also for an increased publication and distribution of research reports.

TURBULENCE *and* COMBUSTION

In the Pulverized-Coal Furnace

By B. J. CROSS

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THE term turbulence as applied to combustion in furnaces refers to a disturbed condition of the furnace atmosphere resulting in a mixing of the combustible and air which is conducive to more rapid and more nearly complete combustion. It is generally considered to be a necessary and desirable condition in furthering the combustion process. In the earlier pulverized-fuel installations before the development of water-cooled furnaces, pains were taken to avoid excessive turbulence in the furnace. Flames could not be permitted to brush the furnace walls, and secondary air was admitted at low velocity and in distributed ports in such a manner as to produce what were called "soft" flames that would not be destructive to the refractories. Combustion rates were kept low to avoid high furnace temperatures so that excessive slag would not be formed.

In completely water-cooled furnaces a high degree of turbulence is essential. The most active combustion is localized as near as possible to the burner zone, leaving to the after part of the furnace the function of continuance of the combustion to an economic degree of completion. To accomplish this localization of the active combustion zone, intensive turbulence is required. It is no longer necessary to favor the furnace walls, and primary and secondary air at high velocities may be used. The high rate of combustion in the burner zone is possible because of the relatively high concentrations of the reactants, oxygen and fuel. They cannot, however, be made to combine any faster than they can be brought into contact and turbulence is necessary to produce mixing. As combustion proceeds, the furnace atmosphere becomes depleted of its oxygen and is diluted with the products of combustion. The last of the carbon must be burned in an atmosphere containing between two and three per cent oxygen. A continued turbulence is, therefore, desirable to keep the loss due to unburned carbon within economic limits.

Actually it would be difficult if not impossible to avoid turbulence in a furnace. Any discussion of the subject involves, therefore, the degree of turbulence obtained rather than its presence or its absence.

In a pulverized-coal furnace a primary turbulence is inherent in the streams of fuel and air. A secondary turbulence is produced by the impingement of or interaction between these streams. These terms, primary and secondary, apply to the order of incidence rather than to the order of importance. The mechanism of the production of these two types of turbulence is quite different.

LAMINAR AND TURBULENT FLOW

In a fluid flowing in a pipe or duct the condition of flow at low velocities is termed viscous or laminar. In this condition, the elements of flow are parallel. The velocity is highest at the center of the duct and grades off to zero in the stationary film at the periphery. The stream appears to be made up of concentric cylinders, one slipping upon another.

As the velocity is increased, the parallel elements of flow are broken up, and the flow becomes turbulent. In such state of flow eddies and cross currents appear and the velocity of the stream becomes more nearly uniform across its section. At the periphery of the stream the stationary film is thinner and the velocity near the film is higher than for laminar flow.

The point, or rather zone, of transition between laminar flow and turbulent flow is determined by the Reynolds criterion

$$\mathrm{Re} = \frac{\text{Velocity} \times \text{diameter} \times \text{density}}{\text{Absolute viscosity}}$$

or to reduce the number of terms

$$\mathrm{Re} = \frac{\text{Velocity} \times \text{diameter}}{\text{Kinematic viscosity}}$$

Fig. 1 shows Reynolds' number plotted against a factor proportional to friction on the surface of the confining duct. The flow up to the value 2500 is laminar, between 2500 and 3000 indeterminant, and above 3000 turbulent. As the absolute values of the friction factor vary somewhat with a number of factors, such as the size of the duct and the condition of its surface, the scale on the ordinate has been omitted.

For air at room temperature, the critical velocity, assuming a unit diameter, is quite low, about one half foot per second. However, because of the rapid increase in kinetic viscosity, the critical velocity will increase with temperature. Fig. 2 shows the change in the critical velocity of air as the temperature is increased. Even at 3000 F, the limit for laminar flow is around 10 fps.

While in the foregoing, the fluid stream is assumed to be confined, the same considerations apply to flow in an open jet. In an unconfined jet, however, and more particularly jets consisting of a burning mixture, velocity, diameter, and viscosity all change along the path of the jet.

The ordinate values of Fig. 1, which in flow in ducts is a measure of wall friction, represent in unconfined jets the drag at the boundary of the stream upon the ambient atmosphere. This drag causes eddies at the boundaries which promote mixing of the stream with the surrounding gases.

In laminar jets, the stream changes but little in diameter as it issues from the orifice. See Fig. 3. This is probably because of the fact that the flow elements at the periphery of the stream have a relatively low velocity compared to the average and the drag on atmosphere is correspondingly low. The discharge from a stack on a windless day shows this characteristic flow. Another example of a laminar flow is the smoke from an idle cigarette in a quiet room.

A marked characteristic of a turbulent jet is its expansion as it issues from the orifice, Fig. 3. The boundary of the stream appears woolly and eddy formation can be plainly seen.

The expansion of the jet as it issues from the orifice is due in part to the slowing up of the velocity and in part to the velocity component at right angles to the direction of flow. This radial component of velocity gives the jet a fluttering characteristic which may actually produce a vibration. At sufficiently

Contributed by the Fuels Division and presented at the Joint Meeting, Birmingham, Ala., November 7–9, 1940, of the Coal Division of the American Institute of Mining and Metallurgical Engineers and the Fuels Division of The American Society of Mechanical Engineers.

high velocities, an audible note may be produced. This fluttering of a jet may be demonstrated by means of streamers of light silk ribbon or thread held in its path. The action is similar to that of a flag, flying in a stiff breeze.

The eddying noticeable at the boundary of a turbulent jet causes a feathering off of the stream in small vortexes which is

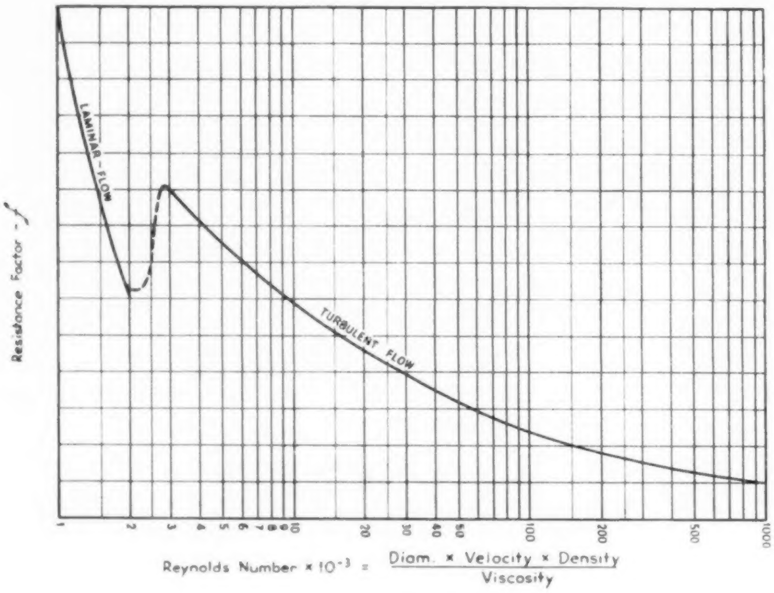

FIG. 1 REYNOLDS' NUMBER

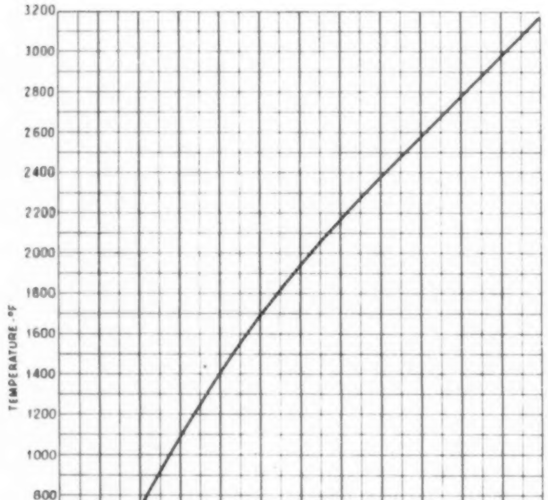

FIG. 2 CRITICAL VELOCITY VS. TEMPERATURE

helpful in securing ignition. A pronounced eddy will occur at the mouth of a blunt burner nozzle. This eddy may be accentuated by means of a restriction in the nozzle throat. These eddies serve as points of ignition. While the average velocity of the stream may be well above the velocity of flame propagation, the formation of these eddies results in boundary velocities much lower than the average. Otherwise the flame would be blown away from the burner and ignition would be unstable.

At the velocities occurring in furnaces laminar flow cannot occur. The jets of primary and secondary air are both in turbulent flow. Probably the nearest approach to what may be called laminar combustion is the candle flame. The vaporized and flaming combustible from the wick of a candle rises without turbulence and the air for combustion induced partly by convection and partly by induction also is in laminar flow. If we consider the flame and the envelope of air which supports combustion as candle flue gases, the final CO_2 content of the gases of a candle burning in open air will be about 4 per cent. By adding a chimney and controlling the air supplied, the CO_2 may be increased to a maximum of $10^1/_2$ to 11 per cent with, however, the production of much smoke and soot. At these maximum CO_2 values, the flame is at the point of being extinguished. By the further addition of an air deflector similar to that used on kerosene lamps, to increase the velocity of air at the flame envelope, the CO_2 may be increased to about 6 per cent without smoke.

Incidentally, in the volume occupied by the visible flame, the combustion rate of a candle is somewhat over 2 million Btu per cu ft per hr. Such a high rate of combustion is possible, partly because of the large ratio of surface to mass and also because oxygen is supplied to this surface at relatively high concentrations. The highest temperature of a candle flame is near the surface where combustion is taking place. This high surface temperature induces convection currents that rise swiftly and wipe off the products of combustion and permit the contact of fresh air richer in oxygen with the combustible. The final combustion at the tip of the candle flame takes place in an atmosphere containing about 16 per cent oxygen. If the oxygen content at this point is reduced even to 14 per cent, combustion is incomplete and smoke results. With an atmosphere containing 4 per cent CO_2 (16 per cent O_2) supplied at the base of the flame, the candle will not burn.

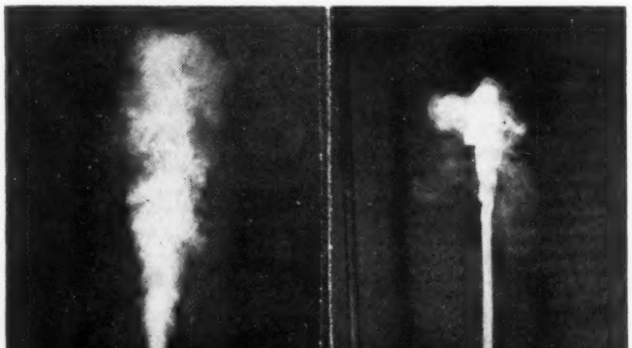

FIG. 3 TURBULENT AND LAMINAR FLOW IN JETS

METHODS OF FIRING PULVERIZED-COAL FURNACES

Turbulence within a furnace is a result of the inherent turbulence of the jets, the impingement of the jets upon each other, and the turning and eddying due to the confinement of the jets by the furnace walls.

Air for combustion is introduced into the furnace as primary

air which carries the fuel, and as secondary air, the remainder of that required. The function of the primary air is to introduce the fuel so that ignition is prompt and stable and to distribute the fuel so that all parts of the furnace may be utilized in combustion.

Secondary air is introduced into the furnace at or near the burners in a manner designed to promote speedy mixing with the burning fuel of the primary air stream.

Relatively high pressure is provided for the primary air, ranging from 6 to 15 in. water gage, depending upon the method of firing. Secondary air which is the larger quantity is supplied usually at somewhat lower pressure primarily as a matter of economy.

Fig. 4 shows diagrams of various methods of firing for pulverized-coal furnaces. The early installations of pulverized coal operated with secondary air supplied with natural draft. In natural draft furnaces, Fig. 4(*a*), the chief source of turbulence is in the primary air jets. Vertical firing is the rule and a long path is provided for the flame. Secondary air, induced by furnace draft enters at low velocity in ports distributed along the path of the flame. A larger number of small burners is more effective in producing turbulence than fewer large burners. For this reason the storage system is best adapted to this method of firing, as increasing the number of burners involves only the relatively small expense of additional feeders. In direct-fired systems, economy dictates the use of as large mills as possible and the division of the mill stream to a large number of burners is not very practical.

A logical development of the natural-draft method of firing was the addition of forced draft, Fig. 4(*b*). Secondary air is introduced in smaller high-velocity jets. In order to break up the primary air streams quickly, the admission of secondary air is closer to the coal-burner nozzles. Water cooling of the front and side walls permitted the higher combustion rates engendered by the greater degree of turbulence obtained. While this system has been used with direct firing in both large and small

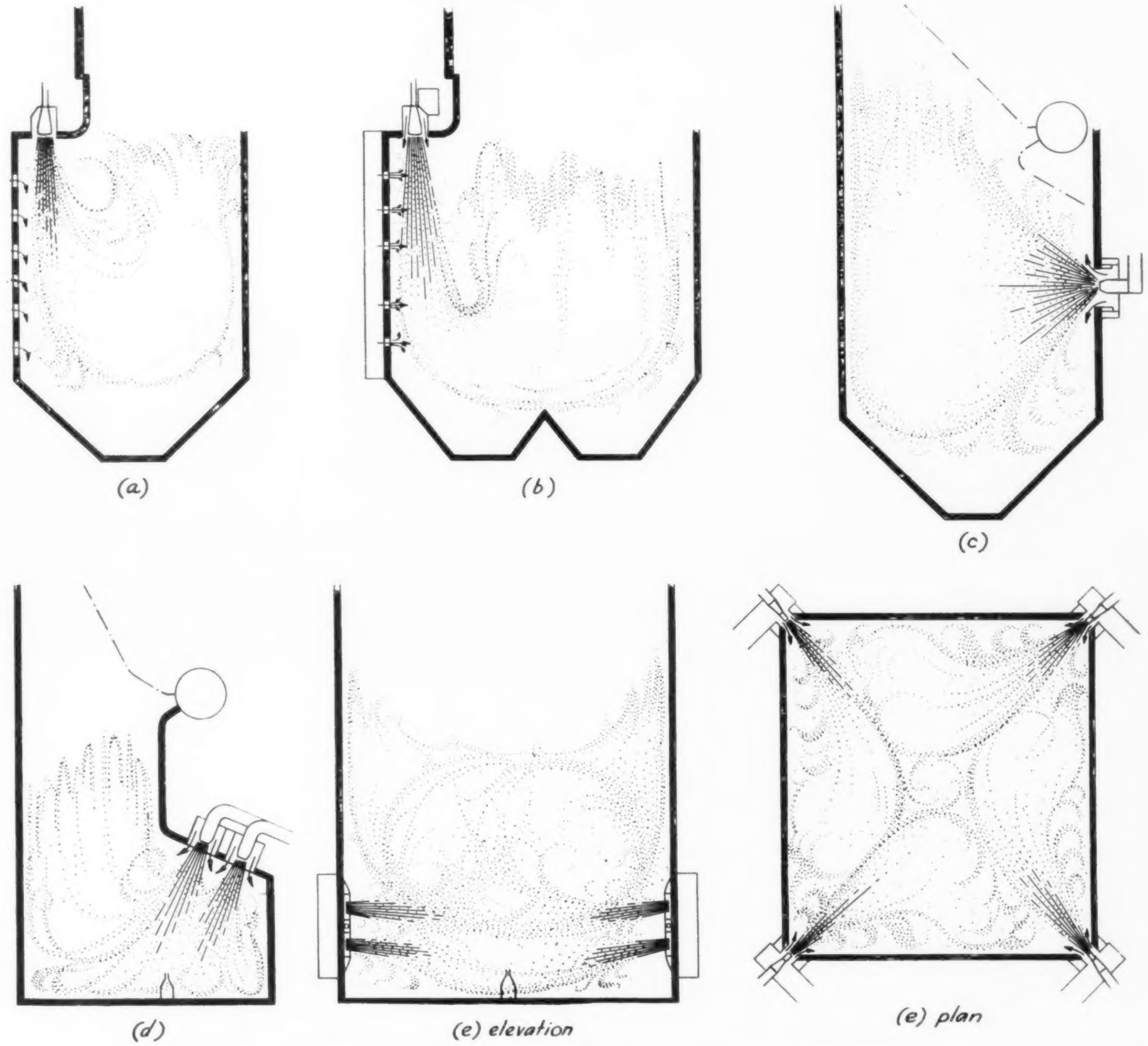

FIG. 4 DIAGRAM OF FURNACES SHOWING FIVE BURNER TYPES AND ARRANGEMENTS
(*a* = Vertical, natural-draft; *b* = Vertical, forced-draft; *c* = Horizontal, "turbulent-type" burner; *d* = "Impact-type" burner; *e* = Corner-fired burner.)

units, the advantage of storage system also applies to the method of firing. Furnaces of this type are often fired from two sides and as many as twenty burners have been used. In completely water-cooled furnaces, combustion rates as high as any in modern practice have been obtained.

The next development in firing method was based on the discovery of the turbulence which already existed and the "turbulent" burner, Fig. 4(*c*), was devised. This burner fires horizontally and all of the air used for combustion is introduced through the burner opening.

In order to distribute the coal across the furnace, the primary streams are given a whirl within the burner nozzle either by providing a fan scroll entrance to the burner or by placing propeller-like spinners in the burner mouth. The secondary air is also given a spin by controllable tangential vanes at the inlet to the burner throat.

The whirling of the primary air stream in addition to effecting distribution of coal also provides a large surface to the jet for contact with the secondary air. The control of spin of the secondary air permits it to be regulated so that it does not strike the primary air stream forcibly until ignition is well established. The shape of the flame can also be controlled by the secondary air vanes.

Horizontal turbulent burners are well adapted to direct firing as they may be of large capacity and few in number. Usually two or four burners are used, although in installations of small capacity single burners have been successful. In storage-system installations as many as eight burners have been used.

Fig. 4(*d*) represents what might be called an impact burner. This type of burner is used exclusively for slagging-bottom furnaces. The burners are usually set in an arch located low in the furnace or sometimes in side walls and inclined downward toward the furnace bottom. High velocities of both primary and secondary air are used and these streams impinge on the furnace hearth. A high degree of turbulence is obtained resulting in the high local temperatures necessary for slagging.

Fig. 4(*e*) represents a corner-fired furnace. In natural-draft furnaces, practically all of the furnace turbulence is achieved as a result of the primary air streams. While this primary turbulence has a lesser role in the vertical-fired forced-draft and the horizontal-fired furnaces, it still is the principal factor in effecting mixing.

In the corner or tangentially fired furnaces, although both the primary and secondary jets are in a high degree of turbulence, mixing is due in greater part to the interaction of these jets. Obviously, a minimum of four burners is necessary for this type of firing. Two burners to a corner give greater flexibility in load and three and four burners per corner have been used. The burners are usually directed to a 6- or 8-ft-diam tangent circle. On recent installations the burners are adjustable so that the tangent circle may be changed while the furnace is in service.

The distance from the burner mouth to the tangent circle is short and the jets impinge at high velocity. The cyclonic action set up by the burners causes, in the rectangular furnace, series of eddies, so that the cross section of the furnace is completely filled with the burning mixture. The cyclonic disturbance persists to some degree to the furnace outlet and is effective in completing the combustion of the coke particles. The gases rise spirally in the furnace and the direction of flow is being constantly changed. The carbon particles which are very dense compared to the gases tend to move in straight lines. Their position relative to the gas stream is, therefore, constantly changing.

A high degree of turbulence is possible with the tangential system of firing. It is applicable to both slagging and dry-bottom furnaces.

Assuming that the burner design and arrangement is such that the energy of the primary and secondary air streams is usefully employed in producing turbulence, the degree of turbulence attained is measured by the velocity of these streams. The kinetic energy of the gas flowing out of the furnace is fixed by its mass and velocity, that is, in a given furnace by the amount of fuel burned and the amount of air introduced with it. The difference between the kinetic energy of the entering streams and that of the gases leaving the furnace may be considered the equivalent of the turbulence produced. As the energy of the gas stream leaving the furnace is constant for a given condition of rate and excess air, the degree of turbulence created in the furnace is proportional to the energy of the streams entering it.

EFFECTIVENESS OF TURBULENCE IN OBTAINING COMPLETE COMBUSTION

The effectiveness of turbulence in the furnace may be measured by the amount of unburned carbon in the ash leaving the furnace. As the cost of supplying air to the furnace increases with the velocity imparted to it, there must be an economic limit to the pressures used. In this, the law of diminishing returns applies and the economic limit may be established empirically.

In Fig. 5 the percentage of combustible in the ash leaving the furnace is plotted against the pressure of the secondary air. There is a definite reduction in the carbon loss as the secondary air pressure is increased. The excess air was held constant during this series of tests. These tests were made on a furnace fired with horizontal burners. The pressure of the secondary air was regulated by the vane opening.

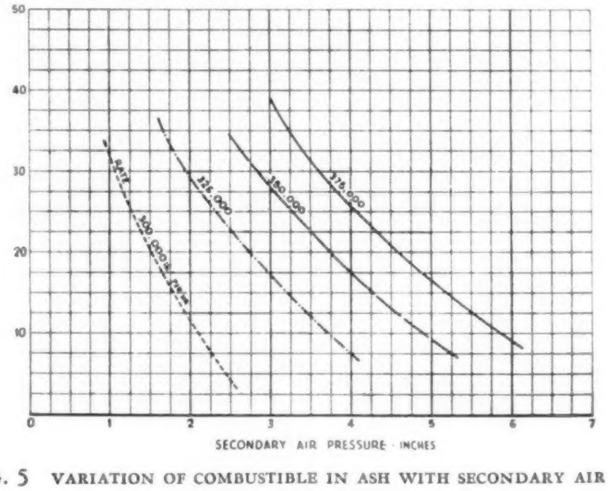

FIG. 5 VARIATION OF COMBUSTIBLE IN ASH WITH SECONDARY AIR PRESSURE—TEST RESULTS

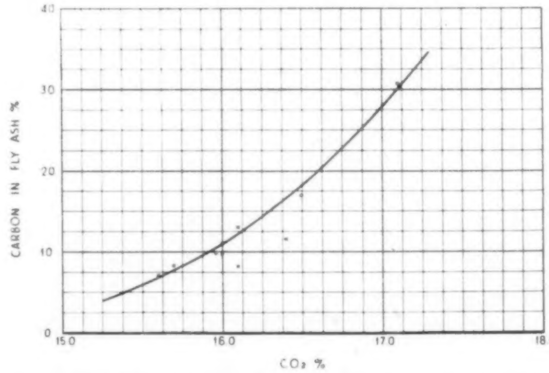

FIG. 6 VARIATION OF COMBUSTIBLE IN ASH WITH EXCESS AIR—TEST RESULTS

In Fig. 6 the carbon in the ash is plotted against excess air at constant rating. During this series, the secondary air pressure was held practically constant.

In Fig. 7 are shown selected data of a series of tests made on a tangentially fired furnace. Secondary air pressure, excess air, and carbon loss in the flue dust are plotted against rating of the boiler. The feature of this graph is the carbon loss which makes practically a flat curve with increasing rating and decreasing air supply. The explanation may be in the increasing secondary air pressure which increases the degree of furnace turbulence.

The chart sections which appear on this graph are parts of a record of furnace draft which were taken with a sensitive gage using a high-speed clock. This gage indicated a rapid pulsing of the furnace atmosphere which is believed to be associated with furnace turbulence. The frequency is from 4 to 6 cycles per second, and as may be seen, the amplitude increases with rating. The individual pulses are too high in frequency to register on a U-tube or inclined draft gage. The gage used was of the diaphragm type and had no orifices or other damping devices. The moving parts of these diaphragm gages have inertia and also their own period of oscillation so it is not likely that the graphs are a true record of the furnace vibration. It is believed, however, that the indications are relative and present a comparison between two furnaces or for the same furnace under different conditions.

Similar furnace draft graphs are shown in Fig. 8. These records are for three different furnaces located in the same plant and operated close to their design rating. Unit *A* is forced draft vertically fired. Units *B* and *C* are tangentially fired, *C* being a higher-capacity unit than *B*. The amplitudes of the furnace-draft graphs are in the same order as the secondary air pressures and the carbon losses are in inverse order to these pressures, this despite the fact that the combustion rates increase in the order *A*, *B*, and *C*.

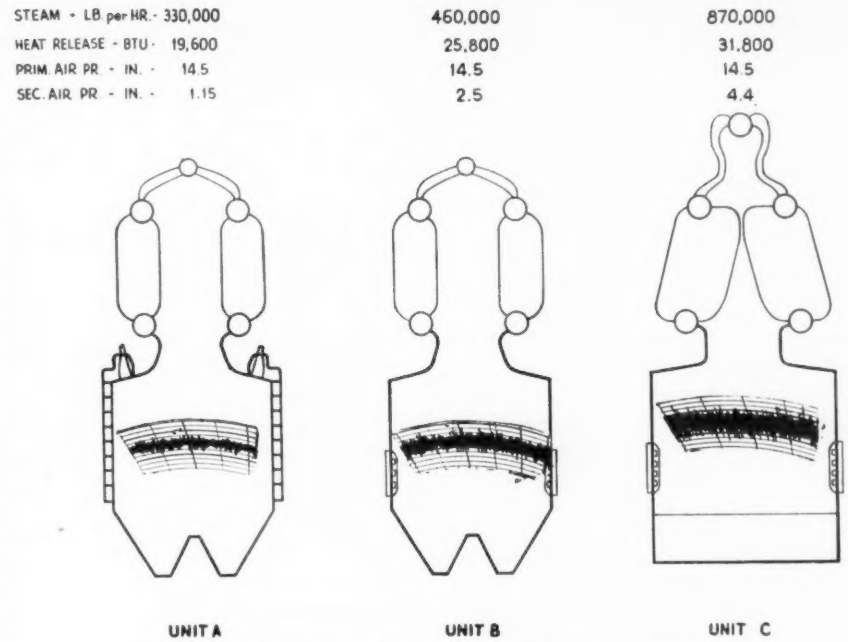

FIG. 8 FURNACE-DRAFT VIBRATION GRAPHS—TEST RESULTS

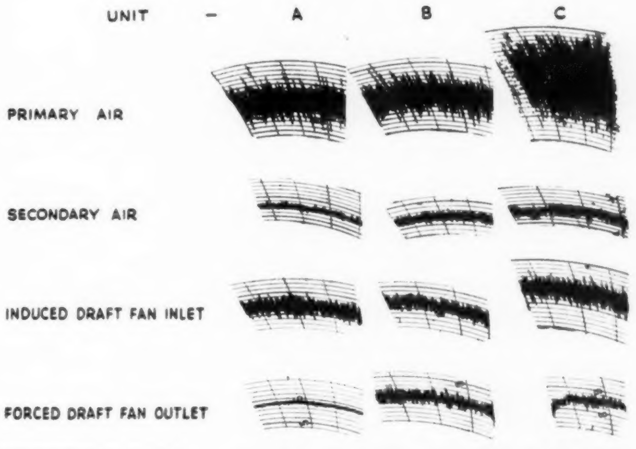

FIG. 9 VIBRATION GRAPHS OF PRIMARY AND SECONDARY AIR STREAM—TEST RESULTS

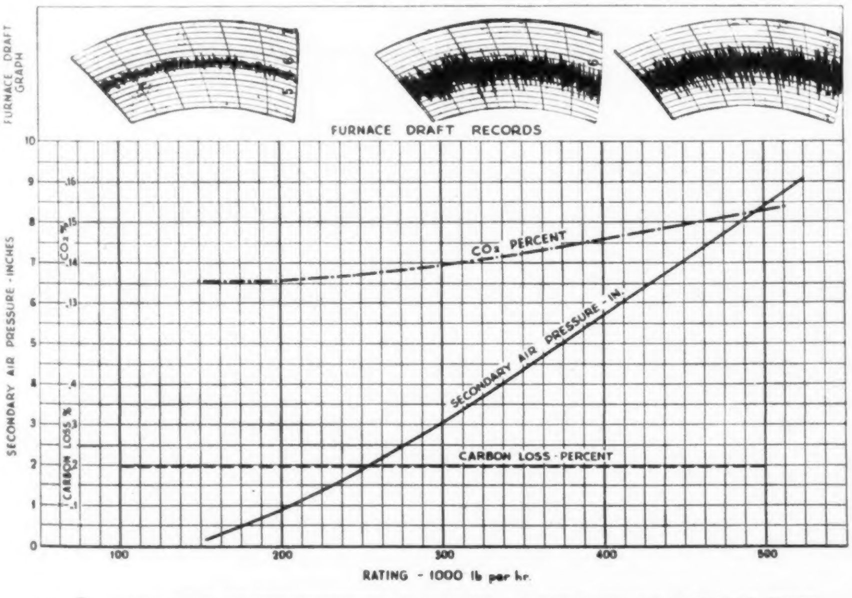

FIG. 7 VARIATION OF COMBUSTIBLE OF ASH AND SECONDARY AIR PRESSURE WITH RATING. FURNACE DRAFT GRAPHS—TEST RESULTS

Fig. 9 shows the graphs of primary and secondary air pressures for the same three furnaces. These are believed to be indicative of the degree of turbulence of the respective streams.

Of particular interest are the graphs for the primary air streams. The high frequency and wide amplitude of these vibrations appear to be characteristic of such streams. The same pattern of graph is observed in the discharge streams from direct-fired mills. The amplitude of vibration increases with loading of the mills, that is, with increasing density of the stream.

No explanation of these graphs is offered nor is any claim made except that they are believed to be associated with vibrations resulting from turbulence. The furnace graphs are fairly constant in

(*Continued on page 210*)

ACCIDENT INVESTIGATION *and* CAUSE FINDING

By EDWARD R. GRANNISS

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THE time has long since arrived when we should be able to justify the collection of accident-cause statistics on utilitarian grounds. It is unfortunate that, in a country where more than 16,000 persons die annually from industrial accidents and 1,500,000 more are severely injured, we do not know more about the causes of these accidents. It is unfortunate because accident causes are the materials out of which safety is made and, as a rule, today's statistics do not supply the data which are necessary for preventive work.

In reviewing national or state tabulations, we are frequently confronted with information which is offered as a substitute for "cause" data. It is shown, for instance, that nearly one half of the industrial injuries are caused by falls or while workmen are handling materials.

It is, of course, interesting to know that many of the persons injured had falls of some kind. But there are so many places a man can fall from, so many places a man can fall into, so many objects he can fall over or against, and so many reasons why he might fall—including bodily and mechanical causes, that the mere fact there were numerous falls helps us very little, if at all.

The same is true of "handling-material" accidents. To be sure, there are a great many of them. But, when we realize the tremendous number of materials handled, and their great variety, is it any wonder? Workers handle materials from the minute they go on the job until the final whistle blows. Likewise, everyone is precariously balanced on two feet with a constantly shifting center of gravity through most of the working day. The exposure to accidents from these two items is enormous. It would be surprising if accidents associated with them did not lead all others.

The inexact use of words has also proved a serious handicap in accident prevention. Recent publications, from sources which should be considered authoritative, still list under "causes" not only such items as "falls" and "handling objects," but "burns," "electricity," and "vehicles." Obviously, none of these items should be considered an accident cause. A fall is an accident; handling objects is a type of job performance; a burn is an injury; and electricity and vehicles are agencies, perhaps associated with accidental injuries.

If these errors were only grammatical, they could be quickly dismissed. But they are more than that; they are mistakes which have been copied in industry and introduced as cause headings in record systems. Subsequently, such records prove of slight value because the reasons why the accidents happened do not appear. Under causes, we expect to find unsafe mechanical and physical conditions, unsafe acts of workers, and unsafe personal factors, such as lack of training and physical infirmities. These would indicate specifically the needed corrective actions.

MORE ACCURATE ACCIDENT REPORTS NEEDED

More information concerning how and why bruises and fractures happen in industry is desirable. Where can it be procured? The answer is—In industry itself. National and state accident statistics are published in their present form for only one reason; it is the only form in which accident data from most sources are available. If better detail is to be forthcoming, the improvement must originate in the accident reports now being prepared in our various plants.

Reports of accident investigations from industrial plants, with some notable exceptions, are largely incomplete and their accuracy frequently is questionable. There are three possible reasons for this: (1) Desire on the part of the person who makes the report to conceal or obscure certain unsafe conditions for which he was responsible; (2) inability of the investigator to recognize or to describe the proper cause or causes and (3) lack of interest on the part of the responsible plant authorities.

Under the laws of most states, information placed in accident reports concerning "cause" has no bearing whatsoever on the payment of claims. Specific schedules of compensation payments, arranged in accordance with injury severity, are not affected by any negligence on the part of either employer or employee. In spite of the fact that a change was inaugurated nearly 30 years ago in industrial accident legislation, the influence of an ancient regime still affects some of our accident reporting.

The type of accident-cause data most affected by this backward attitude is where possible mechanical or physical protection has not been provided. In many cases accidents happen because of unguarded or inadequately guarded equipment. But it is a fact that a careful man can work for a period of time, surrounded by machine or other hazards, without suffering accidental injury. Proper instruction and supervision will lengthen this period. What is more natural, then, than for a supervisor to report, under "cause," that the injured employee carelessly ignored instructions, rather than to report the poorly guarded condition, the correction of which was largely a matter of his responsibility?

Safety directors generally agree that, where an unguarded condition exists, it should always be reported, and that unsafe acts of workers should be shown as secondary to unsafe physical and mechanical conditions. Possibly, the unbalanced accident-cause ratios of 85 per cent ascribed to unsafe acts, and 15 per cent to unsafe physical conditions, are partially the result of a tendency to keep unsafe machine and building conditions out of reports.

While we cannot be sure of all the reasons for poor reporting, probably the inability of laymen investigators to determine and describe accident causes is one of its greatest weaknesses. To what degree of perfection accident investigations should be carried out has yet to be determined, and it is possibly a matter for local decision in accordance with each type of industrial work.

One reason why the accident investigator in industry is encouraged to report first the unsafe machine or building condition is that here is one type of cause which he can be reasonably sure of reporting accurately and one place where, when corrective measures are taken, no further accident from the same source should happen. With the manner of investiga-

tion commonly made at present and in consideration of the time available and the training of the average investigator, personal causes probably cannot be stated with the same accuracy, even though there is every reason at least for making the attempt.

DIFFICULTIES OF DETERMINING PERSONAL CAUSES OF ACCIDENTS

Many accidents are due to temporary emotional reactions that even a psychiatrist might have trouble in locating. There probably is a much closer relation between such common matters as unpaid grocery bills and industrial injuries than ever has been suggested in the accident records of any plant. No employee leaves his worries, his dreams, or any of his own private thoughts behind when he punches a clock in the morning.

Neither can the average investigator, without medical training, be depended upon to determine with complete accuracy such bodily conditions as might enter into the accident cause. Only infrequently do we read in a report that the injured was unaccustomed to his new bifocals at the time of his fall, or that fatigue was the most important of the factors which contributed to a dropped object. Here is a field of industrial-accident prevention to which more attention must eventually be paid.

The third weakness in accident reports arises from what is either a lack of interest or failure to attach sufficient importance to the investigation of individual accidents on the part of men charged with safety in the plant. It is evidenced frequently by a complete absence of accident reporting or in the assignment of such work to clerks and others who are wholly unqualified. This apathy, occasionally noted by national bodies and by state and insurance inspectors, is difficult to explain, but probably indicates a lack of interest in safety. Callousness of attitude, however, is growing less noticeable each year.

PROCEDURE OF INVESTIGATING AN ACCIDENT

How then should an accident be investigated (1) that its cause or causes may be isolated for later attention, and (2) that, upon being entered in the records, its cause and incidental details may be comparable with those of other accidents from the same or other sources? Accidents may be investigated according to formula:

1 The injury first attracts attention and its details, as far as they are known at the time, are written down.

2 Note whether an object, tool, machine, building detail, or toxic substance was most closely associated with the injury.

3 Determine the part of the object, such as the gears on a machine, which may have been involved.

4 Was the object or its part associated with the injury because it was unguarded, defective, in the wrong place, or otherwise unsafe?

5 Then comes the identification of the accident type. Did the injured person fall into the machine or was he struck by the object previously named?

6 Next indicate the unsafe act of a person which precipitated the selected type, the act which caused the injured to be caught in the unguarded gears or to slip on the oil on the floor, if such an act existed.

7 Finally, the unsafe personal factor which brought about the unsafe act (as perhaps lack of skill or poor eyesight) is to be determined if possible.

By this method, the unsafe mechanical agencies will always be named, as will other contributing factors, when they exist. This method will develop data of a type deemed necessary for recording in the "Proposed American Standard for Compiling Industrial-Injury Causes."[1] Thus, it would have the added advantage of being comparable on a state-wide or national basis, should we ever attain that desirable point in the compilation of industrial-accident statistics.

APPLICATION OF ACCIDENT CAUSE DATA

Now, as to the uses for cause data collected through accident investigations, there are, in fact, two separate applications: (1) Cause data may be used at the location where the accident happened; and (2) such data may be compiled by central collecting bodies, as national and state labor departments and the National Safety Council. The only difference should be the greater detail needed at the plant for immediate preventive measures, including names, departments, etc.

Mass statistics on accident causes will prove useful in long-range accident-prevention programs. They indicate to machine builders, for instance, those machines or parts of machines which need redesigning for better safety; and they will show the need in particular industries for improved ventilation, illumination, and the like. In the individual plant, the need is usually more immediate, as for a certain guard on a specific machine or the need for providing glasses or easing financial worries for a certain employee.

An investigation which at present would suffice for national records might fall far short in supplying preventive data in the plant. As an example, in three separate accidents men were injured by objects falling from suspended loads. The mishaps were all due to the violation of a common safe-practice rule that men shall not expose themselves to loose objects overhead. If many accidents were being considered, from the viewpoint of mass statistics, a proper educational program would be suggested, and probably would do some good. Yet, more detailed investigation in these cases developed the need for far more pertinent action at the plant. In the first case, the injured man was found to have poor eyesight and did not know when he passed under an overhead load. In the second case, the employee was aware of the chance he took, but he was a piece-rate worker and the shortest route to his raw material took him under a traveling crane. Otherwise, he would have had to walk all around the department, taking several extra minutes for the round trip, which would have cut deeply into his day's pay. In the third case, the injured had been told several times that he was not to pass under a loaded scaffold, but had disobeyed orders.

Thus, in not one of the three cases was correction a matter of education alone, as effective investigation showed. In the first case, a man had poor vision, in the second the job layout was wrong, and in the third an employee had the wrong mental attitude—and needed something more drastic than instructions. Plant-safety supervisors, primarily, must consider their own detailed cause data and use state or national statistics for supplemental guidance.

Another example is found in a group of automobile accidents which happened at an intersection of two streets. The common cause was noted as "traveling too fast for conditions." In one case, a chauffeur was going too fast because the delivery schedule assigned to him allowed insufficient time; in another case the driver's judgment of speed was bad; another's thoughts were elsewhere; while still another was confused by the operation of a new car he was not yet accustomed to driving. If we deal only with the immediate condition, "going too fast," we will not correct any of the conditions inherent in the drivers, out of which other and different accidents are likely to occur.

[1] Refer to this document for further details; copies may be procured from the American Standards Association, 29 West 39th Street, New York, N. Y.

There is, of course, considerable value in knowing the more common practices, as found in mass statistics, because there are ways in which men may be protected against their personally inherent accident-producing tendencies. The first way, of course, is through mechanical and physical safeguards. Stop signs can be installed to slow up traffic at intersections. Guards can be installed on machines to keep abstracted operators from putting their hands in danger zones. Unfortunately, we do not have even these data in our records, so we install guards as dictated by personal judgment. Safety education, too, helps to make men hazard-conscious and, therefore, to be cautious under certain circumstances. We can afford to relax neither of these activities while working for better accident investigation and improved records.

WHO SHOULD INVESTIGATE ACCIDENTS?

The best qualified person who is able to reach the scene first should report an accident. Where compensation insurance is carried, the burden is sometimes left with the visiting inspector. It should not be the responsibility of state or insurance inspectors to investigate accidents, because: (1) The causes may have become quite obscure and difficult to discover by the time an out-of-plant man makes his visit. (2) The one who can best ascertain the actual facts from the injured person is someone who knows him and is in a position to talk about intimate things, such as family conditions, unpaid bills, etc. We all, naturally, have a tendency to cover ourselves with a formal reserve in the presence of strangers and possibly fail to admit that certain untoward results were caused by our own foolishness, negligence, or weakness. Outside inspectors have an important part to play, however, in convincing plant-safety men of the desirability of accurate accident reports, showing how accidents should be investigated, how reports should be prepared, and records maintained.

It would not be greatly in error to state that all we have learned about safety up to the present time has been acquired through the occurrence of accidental injuries. We learn about accidents only by investigating them and determining their causes. We are yet far from having a comprehensive knowledge of accident causes or, at least, we have failed to record any appreciable amount of such information, as is evidenced by our cause statistics. All of which suggests that industrial-accident prevention is still in its early childhood, despite the lives saved in the last 30 years. Undoubtedly, safety work has been delayed by ineffective accident-investigation methods. One way to greater progress is through more intelligent attention to so basic a procedure as investigation of the individual accident.

Turbulence and Combustion

(Continued from page 207)

frequency and increase in amplitude with the rate of firing. Primary-air density and velocity and secondary-air velocity also increase with rating and the vibration graphs for these streams show an increasing amplitude with rating. It is quite possible that this method is or may be developed to be a measure of at least relative furnace turbulence.

While this paper has been limited to turbulence in pulverized-coal-fired furnaces the considerations will apply with but little modification to gas- and oil-fired furnaces. In stoker-fired furnaces a large part of the combustion takes place in the fuel bed where the streams of air passing through the grates scrub through the fuel at high velocities. There is still, however, about half of the heat generated above the fuel bed. Here turbulence is necessary to break up the stratification of the gas which otherwise would occur.

Improvement in combustion in internal-combustion engines is due in very great part to cylinder heads which have been specially designed and which create turbulence in the compressed gases.

In short, wherever speed and completeness of combustion with minimum excess air is a requirement, turbulence is beneficial.

Combustion is a chemical reaction to which the law of mass action applies. This law may be stated: The velocity of a chemical reaction is proportional to the effective concentration of the reactants. The modification "effective" is particularly significant in the combustion process. Turbulence stirs up the mixture and permits a continual contact of the combustible and oxygen. It makes their concentrations effective.

Atlanta Convention Bureau

EAST LAKE GOLF COURSE WHERE TOURNAMENT IS TO BE HELD DURING A.S.M.E. SPRING MEETING AT ATLANTA, GA., MARCH 31–APRIL 3
(This is the home golf course of the famous golfer, Bobby Jones. For details of the program arranged for the meeting, see pages 236–238.)

The COMPRESSION *of* WOOD

By R. M. SEBORG and A. J. STAMM

FOREST PRODUCTS LABORATORY,[1] FOREST SERVICE, U. S. DEPARTMENT OF AGRICULTURE

CONSIDERABLE work has been done within the last few years on the development of various compressed woods. These compressed woods may be grouped into three classes, namely, ordinary compressed wood, laminated compressed wood, and resin-treated laminated, compressed wood. Such terms as "improved wood," "superplywood," and "compregnated wood" have been used to describe these materials. The latter term has been suggested for use in lieu of the cumbersome term, "resin-treated, laminated, compressed wood."

Compressed wood has been manufactured for some time in Germany under the name "Lignostone" (1, 2).[2] Sears[3] and Olsen[4] hold United States patents for making similar compressed woods. Laminated, compressed wood is made commercially in Germany under the name, "Lignofol" (1, 2). United States patents on similar materials have been issued to Olesheimer[5] and to Walsh and Watts.[6] Interesting mechanical tests have recently been made on laminated, compressed wood by Bernhard, Perry, and Stern (3). Compregnated wood is made in the United States under the name, "Pregwood," and in Germany it is made under the name, "Kunstharzschichtholz" (KHS). A patent of Brossman[7] relates to the making of a compregnated wood. The Forest Products Laboratory has developed a means of forming phenolformaldehyde resins within the intimate cell-wall structure of the wood (4) Upon assembling and compressing, veneer treated in this way gives a superior compregnated wood which can be produced under considerably lower pressures than the ordinary compressed woods (4).

All of these materials are compressed during the manufacturing process and are subject to a certain amount of recovery of compression. It is the authors' object to present the conditions under which recovery occurs and the conditions under which it will not occur for the simplest of the three systems, namely, ordinary compressed wood.

PROCEDURE OF CONDUCTING TESTS

Most of the measurements were made on $^1/_2$ in. thick disks 4.25 in. diam, including both the heartwood and sapwood of flat-sawed hickory. The average specific gravity of the heartwood, based upon weight and volume when oven dry, was 0.72 and of the sapwood 0.69. A few tests were made on $^1/_8$-in. Douglas-fir disks. The general conclusions drawn from the data for the hickory also held for the Douglas fir, indicating that the general character of the results is not dependent upon the species of wood.

Air-dry disks were preconditioned in humidity rooms held at 80 F and 30, 65, 90, and 97 per cent relative humidity, giving moisture contents on the basis of the dry weight of the wood of 6, 12, 20, and 26 per cent, respectively. These disks were then pressed in a disk-shaped mold, into which they fitted snugly, in a hot press at pressures up to either 2000 or 4000 psi. Both pressures were above the average stress at the proportional limit in compression perpendicular to the grain. The compressing operation was done either at room temperature, 78 F, or at temperatures ranging from 266 to 338 F.

The specimens were placed in the closed press under a negligible pressure. The temperature was brought to the desired value in from 5 to 10 min. The pressure was then applied in increments of 286 psi every 30 sec until the desired pressure was attained. After exerting pressure for 20 min, the press was cooled to room temperature, the pressure was released, and the specimens were removed.

Fig. 1 shows the pressing curves for three hickory sapwood specimens which were preconditioned to 26 per cent moisture content and pressed at 78, 265, and 325 F. The upper points at 4000 psi are for a total pressing time of 7 min, whereas, the lower points are for a total pressing time of 20 min. The continued application of load increases the compression but slightly. Wood at the higher temperatures commences to compress at considerably lower pressures than wood at room temperature.

Fig. 2 shows the pressing curves for three hickory sapwood specimens containing 6, 12, and 26 per cent moisture, respectively, all pressed at 320 F. Wood containing the higher moisture contents starts to compress at considerably lower pressures than wood with the lower moisture contents. The compression obtained at 4000 psi, however, varies but slightly.

Tests showed that continued heating before or during pressing affects the compressibility only to the extent that moisture is lost. A specimen containing 12 per cent moisture was heated in the press at 300 F for 30 min under a negligible load. The specimen was removed from the press and conditioned to 26 per

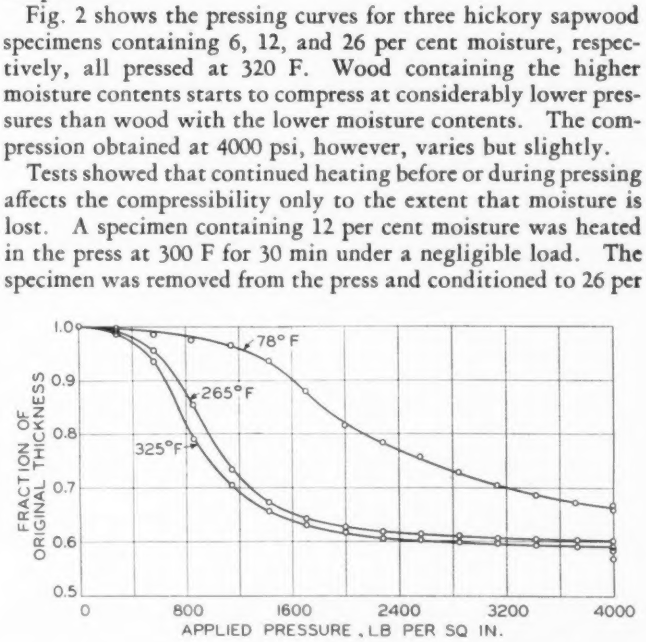

FIG. 1 COMPRESSION OF SAPWOOD OF HICKORY AT THREE DIFFERENT TEMPERATURES UNDER INCREASING PRESSURES (26 per cent moisture content.)

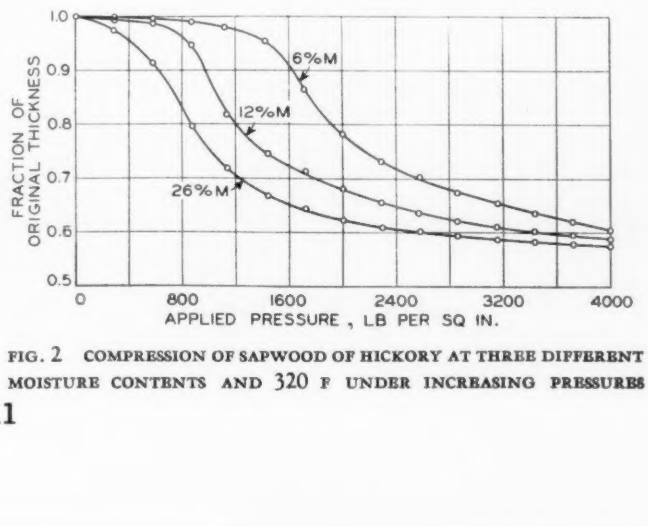

FIG. 2 COMPRESSION OF SAPWOOD OF HICKORY AT THREE DIFFERENT MOISTURE CONTENTS AND 320 F UNDER INCREASING PRESSURES

[1] Maintained at Madison, Wis., in cooperation with the University of Wisconsin.

[2] Numbers in parentheses refer to the Bibliography at the end of the paper.

[3] U. S. Patent No. 646,547, C. U. Sears, 1900.

[4] U. S. Patent No. 1,981,567, A. G. Olsen, 1934.

[5] U. S. Patent No. 1,707,135, L. J. Olesheimer, 1929.

[6] U. S. Patent No. 1,465,383, F. J. Walsh and R. L. Watts, 1923.

[7] U. S. Patent No. 1,834,895, J. R. Brossman, 1931.

TABLE 1 COMPRESSION PROPERTIES OF THE HEARTWOOD OF HICKORY

Equilibrium: Relative humidity (1)	Equilibrium: Moisture content (2)	Pressing conditions: Pressure (3)	Pressing conditions: Temperature (4)	Decrease in thickness from compression (5)	Part of compression retained when reconditioned at prepressing relative humidity (6)	Part of compression retained after water soaking and oven drying (7)	Radial shrinkage, water soaked to oven dry (8)	Tangential shrinkage, water soaked to oven dry (9)
Percent	Percent	Lbs. per sq.in.	° F.	Percent	Percent	Percent	Percent	Percent
...	...	None	78	...	...	...	7.4	11.0
...	...	do	78	...	...	...	8.8	11.1
...	...	do	78	...	...	...	9.2	...
30	6	4,000	338	39.3	...	72	18.3	...
65	12	2,000	316	35.4	101.4	82	18.5	...
65	12	4,000	78	21.3	42.0	8	9.9	10.6
65	12	4,000	298	37.1	101.4	...	17.5	...
65	12	4,000	329	38.6	101.8	91	19.5	...
65	12	4,000	338	...	...	...	...	11.3
90	20	2,000	293	34.0	100.0	67	18.3	...
90	20	2,000	307	33.2	100.0	79	17.9	...
90	20	4,000	78	29.8	38.0	11	9.3	11.0
90	20	4,000	331	35.2	100.3	89	19.2	...
90	20	4,000	338	35.9	...	94	18.6	10.6
97	26	2,000	298	35.3	95.0	75	18.5	...
97	26	4,000	78	33.3	20.0	3	8.3	...
97	26	4,000	284	34.8	93.8	56	14.6	...
97	26	4,000	311	34.3	98.0	74	18.9	...
97	26	4,000	338	35.2	...	92	18.1	...
97	26	4,000	338	37.0	...	95	20.5	...

cent moisture content. Subsequent pressing gave practically the same compression as other specimens conditioned to 26 per cent moisture content which had not been preheated. Heating at the lower moisture contents has no tendency to reduce the compressibility due to a heat set of the wood. The lower compressibility is entirely due to the lower moisture content.

PROCESS APPLIED TO HEARTWOOD AND SAPWOOD OF HICKORY

Tables 1 and 2 give a compilation of the data obtained for the heartwood and the sapwood of the hickory, respectively. The first four columns give the conditions before and during the pressing. Column 5 gives the decrease in thickness resulting from the compression. The compression occurring at room temperature is slightly less than at the elevated temperatures. The moisture content of the wood has a greater effect upon the compressibility at room temperature than at the higher temperatures. At room temperature, the deformation increases by about 56 per cent from a moisture content of 12 per cent to a moisture content of 26 per cent. At the higher temperatures, the variation of the compressibility of the wood with changes in moisture content is practically within the range of experimental error, since the fiber stress at the proportional limit of the wood is greatly exceeded for all moisture contents.

Several of the specimens were returned to the humidity room, in which they were preconditioned, immediately after being removed from the press. The compression which was retained under equilibrium conditions is given in column 6. The specimens pressed at room temperature all lost much of their compression, whereas, the specimens which were pressed at the higher temperatures all retained their compression within an accuracy of 2 per cent. Exceptions to this were specimens which originally had a moisture content of 26 per cent. Some of these lost as much as 6 per cent of their compression. This is due to the fact that these specimens lost some moisture in pressing so that reconditioning to the original moisture content involved a slight swelling which caused the release of some of the compression.

If, on the other hand, the wood is allowed to swell in water after having been compressed and dried, an appreciable part of the dimension decrease, which occurred during compression, is lost for many of the specimens (refer to column 7). The portion of the compression retained, increases with an increase in the pressing temperature and, to some extent, with an increase in moisture content. This is better illustrated in Figs. 3 and 4. When the pressing is done at moisture content above 20 per cent and at temperatures above 325 F, 80 to 100 per cent of the compression is retained.

Column 8 gives the radial shrinkage of the disks (the direction in which they were pressed) after swelling to equilibrium in water. The largest shrinkage in all cases corresponds to the

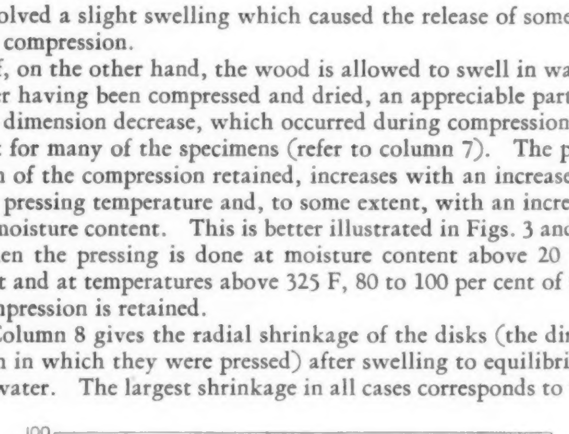

FIG. 3 AMOUNT OF COMPRESSION RETAINED BY HICKORY SAPWOOD AFTER OVEN DRYING AND THEN SOAKING IN WATER

(Specimens pressed at different moisture contents and temperatures.)

TABLE 2 COMPRESSION PROPERTIES OF THE SAPWOOD OF HICKORY

Equilibrium		Pressing conditions						
Relative humidity	Moisture content	Pressure	Temperature	Decrease in thickness from compression	Part of compression retained when reconditioned at prepressing relative humidity	Part of compression retained after water soaking and oven drying	Radial shrinkage, water soaked to oven dry	Tangential shrinkage, water soaked to oven dry
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Percent	Percent	Lbs. per sq. in.	° F.	Percent	Percent	Percent	Percent	Percent
...	...	None	78	...	...	...	...	9.4
...	...	do	78	...	...	...	...	9.5
30	6	4,000	302	45.5	100.0	33	13.9	...
30	6	4,000	320	44.8	100.0	46	15.8	...
65	12	2,000	298	39.6	100.0	49	15.4	...
65	12	2,000	315	35.6	100.0	55	16.0	...
65	12	4,000	298	43.4	99.0	49	16.2	...
65	12	4,000	320	41.7	99.3	64	17.0	...
65	12	4,000	338	42.6	...	...	...	9.4
90	20	2,000	316	41.0	99.0	71	17.8	...
90	20	4,000	266	41.7	...	34	14.1	...
90	20	4,000	307	41.2	101.0	64	16.4	...
90	20	4,000	338	41.7	...	94	23.8	...
97	26	2,000	309	41.3	94.6	65	16.6	...
97	26	4,000	78	38.2	21.0	6	8.6	...
97	26	4,000	266	43.6	...	26	12.1	...
97	26	4,000	284	42.6	92.8	52	15.4	9.2
97	26	4,000	320	44.5	96.0	72	17.3	...
97	26	4,000	320	43.6	...	64	17.0	...
97	26	4,000	320	41.8	...	78	17.8	...
97	26	4,000	338	41.2	...	90	23.9	...

largest retention of compression after soaking and drying. This is due to the fact that the shrinkage of wood is approximately a direct function of the specific gravity of the wood (5). Wood which is permanently compressed to one half of its original thickness will shrink about twice the normal amount. If the compression of wood is entirely lost on soaking in water, then the shrinkage should be normal. Essentially this is the case for the wood compressed at room temperature. Specimens, which have lost intermediate amounts of their compression upon soaking, naturally give intermediate shrinkage values.

Column 9 gives the tangential shrinkage from the water-soaked to the dry condition for some of the specimens. It is interesting to note that these values are the same for compressed wood which has lost but a small amount of the compression, compressed wood which has lost the major part of the compression, and uncompressed wood.

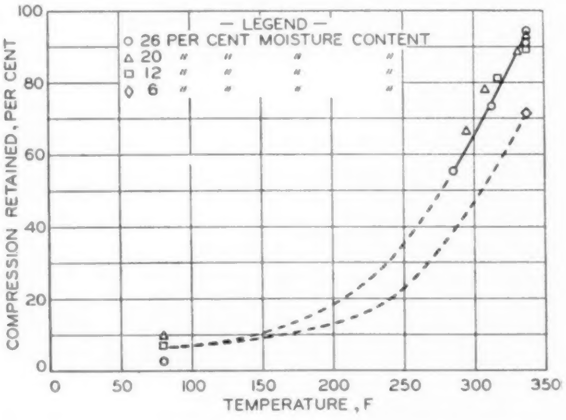

FIG. 4 AMOUNT OF COMPRESSION RETAINED BY HICKORY HEARTWOOD AFTER OVEN-DRYING AND THEN SOAKING IN WATER

(Specimens pressed at different moisture contents and temperatures.)

CONCLUSIONS

The compression of wood increases with an increase in both the moisture content of the wood, up to fiber saturation, and the pressing temperature. When pressures considerably in excess of the fiber stress at proportional limit are applied, the variations in the degree of compression with variations in the moisture content of the wood and the pressing temperature become small. Wood, compressed at elevated temperatures, under high pressures and conditions which do not allow the moisture in the wood to be appreciably lost during the pressing, retains virtually all of its compression when it does not absorb moisture in excess of that in the wood at the time of pressing. Wood which contains 20 per cent or more moisture, when pressed at 325 F, retains at least 80 per cent of its compression even after soaking in water and redrying in the case of the species tested. Thus, it is advisable, when making ordinary compressed wood, to start with only partially seasoned wood or to precondition the wood to at least 20 per cent moisture content and to compress the wood at temperatures somewhat above 325 F, in order to retain the maximum amount of compression under all kinds of exposure conditions.

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THE UNEMPLOYED WORKER[1]

By CHARLES A. MYERS

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

UNEMPLOYMENT has been called "the nation's No. 1 economic problem." While the national-defense effort has for the present overshadowed and minimized this, one of the major concerns of our peacetime economy will undoubtedly again center around workers who are unemployed because of fluctuations in business activity.

Essential to an adequate consideration of the problem and its treatment is an understanding of the human aspects of employment and unemployment—the men and women behind the statistics. To gain this understanding, Professor Bakke and his staff at Yale have been gathering for a period of eight years (1932–1940) first-hand information about unemployed workers and their families in New Haven, by living for several periods with workers and unemployed men, by participating in their search for jobs, by joining in their meetings and social affairs, and by extensive interviewing and intensive study of a small group of unemployed families.

The aim of the study was "to analyze the adjustments and reactions of the unemployed in the light of the fact that they are normal human beings possessing an array of tools for adjustment presented to them by normal life in a working-class community." As Professor Bakke points out, very little previous research "has been undertaken in an effort to picture the unemployed worker and his family adjusting to the problems of unemployment against the background of their cultural preparation for such adjustments." Herein lies the significance of this latest addition to the extensive literature on unemployment.[2]

If this approach is accepted, it is obvious that a study of unemployed workers cannot begin with their experience from the day they became unemployed. How they adjust themselves to this new "obstacle of unemployment," the self-reliance with which they meet it, will depend upon the "equipment" which they bring from their previous experience as workers with jobs. What are the goals, resources, and practices which characterize workers generally? To what extent do these goals foster self-reliance or initiative, traits in which the unemployed are sometimes said to be lacking?

Workers, according to Professor Bakke, have three major goals toward which they are striving: (1) To play a number of socially respected roles in the community, such as a "producer," "job-holder," "employee of a good firm," "holder of a swell job," "a fellow your mates look to," "a thrifty man," "or a good provider;" (2) to attain a degree of economic security involving the sort of a job and standard of living customary among their associates; and (3) to have an increasing measure of control over their own affairs, as well as some understanding of the broader forces that affect their lives.

Unemployment is not the only obstacle to the attainment of these goals; the work experience which provides the basis for their realization has pitfalls, too. In fact, "what loomed up prominently in the memories of workers interviewed were the ways in which their conditions of work had retarded, rather than the ways in which those conditions had advanced their attempts to realize the essential demands of human beings." The hazards of the job were frequently stressed—especially getting along on low and irregular wages, "the threat of machines," "the pace set by the bosses." Frequent frustration in the attainment of their goals, then, had often dulled whatever self-reliance workers did have before becoming unemployed.

What other resources did workers bring to a period of unemployment? Most of them had no more than an eighth-grade education and were trained for their jobs only in the factory. Necessity had been more compelling than choice in determining the occupations they entered. The "one-firm man" was the exception; there was much changing of employers and even occupations during working lives. "Whatever foresight they (workers) had learned in the expenditure of incomes was adapted to the distribution of meager funds over a multitude of necessities."

Efforts were made on the job to have a good employment record, gain a reputation for skill and ability, and even show some originality through making suggestions; but there was a conviction on the part of many workers that "pull" and "discovering the employer's whims" were equally important in providing job permanence. Foresight in obtaining financial security in the form of insurance, savings, owning homes, joining benefit societies, and so forth, was practiced by some, as was the making of helpful community contacts.

With this background of "equipment" in the form of goals, resources, and techniques, what sorts of adjustments did workers make when they became unemployed? How did the period of unemployment and the social services (such as unemployment compensation and relief) modify these goals and practices?

Expecting re-employment by their former employer, many workers did not begin the job hunt immediately. When "pavement pounding" finally started, training useful on the job was of little value when the job was a search for work. The "one-firm man," in particular, was ill-equipped to find work elsewhere. Furthermore, "employment for others creates very little imagination as to what a man may do 'on his own' when no one can use him . . . . Certainly it did not enter the heads of any but a limited few that they might create jobs by undertaking an independent venture."

If the breadwinner was unsuccessful in getting employment, except for odd jobs, additional members of the family frequently entered the labor market and found work. Other resources which the unemployed family could turn to were (in order of importance) credit, savings, charity, loans, selling or pawning of possessions, and cashing of insurance. Economies were made in various expenditures, most frequently in connection with the following: clothing, recreational and community activities, food, insurance, and rent. In view of all these adjustments, it is not unfair to say that "the chief burden of unemployment is still borne by the unemployed themselves."

Unemployment compensation was a "first line of defense" for some, but often an inadequate one. Since the size and duration of benefits are based upon amount and regularity of a worker's previous earnings, these benefits bear no direct relation to the unemployed worker's need. Professor Bakke suggests supplementary benefits for a person's dependents, in order to insure that unemployment compensation shall "fulfill its task of keeping workers off direct relief."

When unemployed families finally turned to relief, new tech-

[1] One of a series of reviews of current economic literature affecting engineering, prepared by members of the department of economics and social science, the Massachusetts Institute of Technology, at the request of the Management Division of The American Society of Mechanical Engineers. Opinions expressed are those of the reviewer.

[2] "The Unemployed Worker" and "Citizens Without Work," both by E. Wight Bakke, New Haven, Conn., Yale University Press, for the Institute of Human Relations, 1940.

niques of self-maintenance were developed. "Obtaining relief is not a simple matter. The unemployed must 'learn the ropes' if they are to receive the maximum possible assistance from this source." The necessity, if on direct relief, to make one's self appear as destitute as possible in order to secure the maximum allowance is in direct conflict with success in providing for one's family through foresight when employed and initiative when unemployed. Furthermore, foresight may even cause a person on work relief to refuse a job in private employment if the latter is likely to be extremely temporary and force the worker again to go through the difficult process of getting on relief. Is he to be condemned for the foresight and planning involved in such a choice?

There is a further point involved here which is basic to the whole question of unemployment and its treatment. Can any form of relief ever be an acceptable substitute for a real job? From some quarters the charge is made that "reliefers" are regarding it as such. As we have already seen, the normal worker has various goals toward which he is striving, and these goals "are not suddenly forgotten and eliminated when he becomes unemployed. They may be modified but not destroyed." It is obvious that an unemployed worker cannot continue to play some of the roles respected in the world of labor. " 'A producer,' 'the holder of a swell job,' 'a fellow your mates look to,' 'a good provider,' 'a man who never lets his family down,' are clearly not terms which describe the man who is wandering from gate to gate begging for a chance to work."

Furthermore, "every week he fails to supply the china pitcher with a pay envelope increases his awareness that economic security is escaping him more completely, but most seriously attacked is his desire to control his own affairs. If the belief that his own qualities and decisions were an important determiner of his own destiny could scarcely survive while he was working, how much chance does it have to survive when he is 'pounding pavements?' "

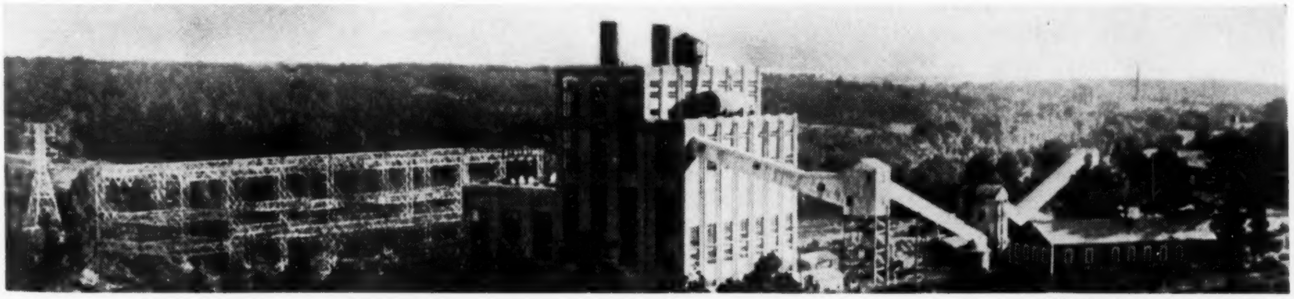
The damage done to a worker's goals by loss of a job is obviously not removed by giving direct relief. "Every goal he seeks to reach as a normal worker recedes further from realization when he turns to relief." He is no longer playing a socially respected role, the margin of safety involved in economic security is not included in the usual relief budget, and the worker has lost much control over his own affairs when he must submit to the judgment of a social worker who decides what he and his family shall get. The "reliefer" may therefore try to rationalize his status, accept lower objectives, and develop practices designed to secure as much as possible from relief sources.

As a means of preventing this form of demoralization, work relief is clearly superior to direct relief. "Work on projects which are well done and efficiently managed increases his prestige among his fellows" and gives the worker a "socially respected role." In providing greater economic security and giving a greater measure of control over one's own affairs, work relief is also preferable.

"Boondoggling" and "leaning on shovels," however, are common expressions with some justification. Can work relief be improved in quality and supervision? This is a question never clearly faced by critics of the W.P.A. In so far as relief projects involve certain useful undertakings and provide steady jobs, they may attract men from less desirable forms of private employment. In so far as they remain as stopgaps for emergencies, "poor quality of product and inefficiency of operation are all but inherent." The quality of labor available is often substandard, the more competent workers are continually leaving for private jobs, promotion and discharge as means of rewarding good work or punishing bad performance cannot be used as they are in private employment, work schedules must frequently be rearranged for constantly shifting groups of men with varying skills, and the best supervisors are already employed elsewhere. Some defects could be remedied, "yet when all possible improvements have been made, work relief will offer men superior opportunity to appear before their fellows in a role which is respected only by comparison with the marginal jobs offered by private enterprise, and with the definitely inferior status available to one on direct relief."

The view that men on work relief are a permanent group, however, does not stand investigation. Professor Bakke reports that "in the eight years covered by this study I have been able to locate exactly two unemployed workers whose attitude coincided without important modifications with the stories (of turning down private employment in order to stay on W.P.A.) told about them by middle-class individuals . . . . Men and women are continually leaving for private employment, and every man whom we have talked to—and we have talked to hundreds of them on these projects—indicated that the minute a job is offered which promises any degree of security, or status, or permanence, there will be no lack of takers for it."

If one is convinced by Professor Bakke's findings, the conclusion is inescapable that some of our public policy on direct relief, W.P.A., and unemployment compensation has been badly conceived and executed. Not the least of the difficulties in the way of an effective program of unemployment relief is the opposition of those persons who lack an adequate understanding of the unemployed worker seen in relation to his goals, resources, and practices growing out of previous employment. It might be a clarifying experience if some of the defenders of the so-called "American way" of handling unemployment could read Professor Bakke's two books.



Atlanta Convention Bureau

PLANT ATKINSON—100,000-HP STEAM GENERATING PLANT LOCATED ON THE CHATTAHOOCHEE RIVER, TEN MILES FROM ATLANTA, GA.
(Work is now in progress in the construction of an additional generating unit of equal size; when completed, it will be the largest generating plant in the State of Georgia. An inspection trip to this plant is to be made during the A.S.M.E. Spring Meeting in Atlanta, Ga., March 31–April 3, 1941. See pages 236–238 for technical program.)

BRIEFING THE RECORD

Abstracts and Comments Based on Current Periodicals and Events

Problems of 1941

THE NATIONAL CITY BANK OF NEW YORK

THE problems of 1941, according to the January, 1941, newsletter of The National City Bank of New York, fall into two parts. The first is to get a job done, namely, to provide all the armament, shipping, and supplies that are needed by this country and Great Britain as quickly as possible. The second is to control the effects of the augmented demands so as to restrain inflationary tendencies. Some observers conclude that these problems in fact are identical—that both can be solved by a diversion of production from passenger automobiles, mechanical refrigerators, and other consumers' durable goods into planes, guns, and tanks, together with appropriate taxation to absorb for defense needs the income which otherwise would have been spent on automobiles and other goods.

This, however, is an oversimplification of the problem. Current comment suggests that the extent to which planes, tanks, and guns can be made in plants designed for other purposes, and the readiness with which peacetime plants can be converted, is frequently overestimated. This is one of the factors, foreseen from the beginning, which causes disappointment with defense progress. Mr. Sloan of General Motors in an address within the last month (December) stated that only 10 to 15 per cent of the machinery and equipment of an automobile factory can be used for turning out such products.

Industrialists and officials charged with the defense effort agree that while the peacetime industries should be mobilized to the utmost, the final machine operations and assembly of armaments require, to a considerable extent, plants and machinery built for that purpose. When these plants are ready and tooled up, they must and will draw upon other industries for parts and accessories, either in semifinished form or ready for final assembly. But the armament-plant construction program has not reached that stage. Mr. Knudsen in his speech to the National Association of Manufacturers on December 13 estimated roughly that "we are 20 to 25 per cent tooled up now. * * * * * I forecast that with your help we could be 80 per cent tooled up by April and the balance by May 31. This is naturally an over-all figure which cannot be applied to specific items but I consider it possible to attain. I ask you to help get it."

MACHINERY THE KEY

The machine-tool industry doubled its production in 1940 as compared with 1939 from $200,000,000 to $400,000,000; and in 1941 expects to produce $600,000,000 or more. Mr. Knudsen, while asking for still more, has warmly commended this performance. Increased output is being accomplished by plant expansion, installation of new equipment, subcontracting, and training large numbers of new men in order to operate equipment as continuously as possible. The National Machine Tool Builders' Association states that nearly half of the nation's machine-tool employees today have been trained on the job since September, 1939.

Machine-tool producers have agreed that their output can be speeded further, but call for a more definite program and scheduling. Their criticisms of the defense effort, and those of others best qualified to judge, concern chiefly the inadequacy of planning and coordination, not only to speed expansion, but to promote subcontracting and to make the most effective use of existing tools.

Study is under way of plans for a vast joint contribution by the automobile and parts industries, and the tool and die makers ordinarily employed by them, toward an airplane-construction program wholly outside the existing aviation industry. That these plants can make a great contribution to the airplane program in due time, and that their resources should be utilized with all speed, cannot be doubted. A heavy bomber, however, is said to contain 25,000 parts. Many are made of materials which the automotive industry does not even use to any great extent, and by processes and methods wholly foreign to automobile manufacture. Even if the automobile plants within a short time could turn out 24,000 of these parts there would still be no finished bombers until machines to make the other thousand parts and plants for final assembly could be completed. The study being made may evolve a practicable plan, but the question is not one for laymen to judge.

Between the two problems of getting the job done and controlling inflationary forces, there is a separation in point of time. The second will become more pressing as the first is solved. As armament plants and equipment are completed, and existing industries are called upon to supply them with parts and materials, it will become possible to determine whether those who say, figuratively, that we should give up butter to have guns are correct, or whether it is truly possible to have both guns and butter through more complete and efficient mobilization of our industrial resources.

Everyone will hope that the challenge, embodied in the need for both guns and butter, will be met; and from the standpoint of raw-material supplies, capital and credit, and potential labor force, given adequate training programs and cooperation, the goal is not beyond reach. However, "business as usual" will not get the job done on time. It is only prudent to prepare for priorities and sacrifices and for measures to counter inflationary trends—first, to make the armament program effective, and second because inflationary demands allowed to run unchecked would lead to disaster.

National-Defense Issues

THE BROOKINGS INSTITUTION

FUNDAMENTAL economic issues in national defense are examined by Harold G. Moulton, president, The Brookings Institution, in a pamphlet devoted to this subject recently issued by the Institution. Dr. Moulton asks four questions:

1 Will the national-defense program require extensive readjustments in the economic life of the nation?

2 Can the defense program be financed without an enormous increase in the public debt?

3 Is it possible to carry through the defense program without a great inflation of commodity prices?

4 Are we inevitably faced with a catastrophic collapse at the end of the war?

Dr. Moulton's pamphlet is an attempt to summarize briefly

the factors, as he sees them, upon which answers to these questions depend. Without attempting to repeat the summaries of these factors as Dr. Moulton presents them, the answers, substantially in his own words, follow:

1 The conclusion from the discussion of question 1 is that the magnitude of the program is not such as to require a profound disorganization of the economic system or a reduction of living standards for the masses. In the first stage of the preparedness program an appreciable expansion of consumer income is possible without handicapping the defense program. But as we pass from the first to the second stage, further expansion of consumer income must be restrained in the interests of rapid and economical mobilization; and in some lines consumption must be reduced in order to permit increased output of war supplies. It is obvious that curtailment of the production of consumer goods should not be made prematurely—for that would involve needless loss of consumer income and waste of resources. It is equally obvious that the decision to make necessary shifts should not be deferred so long that it will impede the war production program. Decision is necessary *now* with respect to the vital issue of *additional* plant capacity versus *conversion*.

2 The answer to the question whether the defense program can be financed without a great increase in public debt is *yes*. It is, moreover, of the utmost importance from the standpoint of future financial and economic stability that we should achieve a balanced budget during this period of high national income.

3 The answer to the question whether commodity-price inflation is economically necessary is *no*. If any substantial rise in the general level of prices occurs, it will be because of a lack of adequate understanding of the sources of price disturbance and the consequent failure to adopt sound national policies and wise administrative procedures. It will not be because of any inherent economic necessity. Whether the primary sources of price disturbance will be adequately controlled of course remains to be seen.

4 The answer to the question whether economic disaster is inevitable at the end of the war will depend chiefly upon how successful we are in maintaining economic and financial stability during the emergency.

The pamphlet concludes with the following observations:

The questions which were considered in Dr. Moulton's analysis involve basic issues of national economic policy. They are, he says, ultimately of more fundamental importance than the technical and industrial problems involved in accelerating the production of war supplies with which we have thus far been chiefly concerned. Up to now the nature of the problem has been comparatively simple. The primary task has been to take up the slack in existing establishments and to expand production facilities in certain specified lines. From now on—as the war effort expands and the industrial slack disappears—the problem becomes complex. We shall be confronted, increasingly, with underlying problems of financial and economic policy, and in the end the efficiency of the war production program itself will largely depend upon the speed and the wisdom with which these basic issues of national policy are settled.

These general economic and financial factors in the situation are not only far-reaching and ramifying in character but they are also *interrelated*. Since not only production problems but also monetary, banking, fiscal, labor, and consumption problems are involved, they cannot be effectively handled on a piecemeal or isolated basis. Such a procedure, as World War experience so clearly demonstrated, leads to inevitable conflicts which seriously retard the mobilization process. What is required is a national program which will effectively coordinate these various elements into an integrated and harmonious national policy. Only thus shall we be able to adjust national consumption in the interests of national defense. Only thus shall we be able to maintain financial stability. Only thus shall we be able to prevent a serious inflation of prices. Only thus shall we be able to carry through the defense program with maximum speed and efficiency. Only thus shall we be able to minimize the difficulties inherent in postwar readjustments.

The formulation and coordination of national economic policies along the lines indicated obviously lie beyond the power, if not the purview, of the Office of Production Management and of the Advisory Commission to the Council of National Defense. Nor can the problem be properly handled by any one of the various financial agencies of the government. Close cooperation among a number of administrative agencies will be required; and since legislation is essential, Congress must participate in the development of the program.

The situation does not, however, appear to require the establishment of any new administrative agency or the setting up of additional formal machinery. It merely requires effective team work, under the leadership of the President, among such agencies as the following: the Treasury, the Board of Governors of the Federal Reserve System, the Federal Loan Agency, the House Ways and Means Committee, the Senate Finance Committee, the Office of Production Management, and the Advisory Commission to the Council of National Defense.

With the adoption of sound economic policies and the development of a coordinated national program, there would be reason for confidence that the defense program could be speedily and effectively carried to completion. Since the magnitude of the requirements—so far as they can now be foreseen—is not such as to necessitate profound dislocations in the economic and financial system, there would also be reason for believing that the problems of postwar readjustment might be successfully met.

Labor in Great Britain

THE INSTITUTION OF PRODUCTION ENGINEERS

THE War Emergency Committee of The Institution of Production Engineers presents in the November, 1940, issue of the *Journal* of the Institution a "Memorandum on the Efficient Utilization of Labor Under War Conditions," which is quoted substantially in full in what follows:

An outstanding difficulty with which all production executives are called upon to deal is that of obtaining an adequate supply of skilled mechanics to meet the requirements of munitions product programs. Prior to the war it was known that the supply of skilled labor was inadequate to meet the reasonably balanced requirements of peacetime manufacturing programs, while the outbreak of war, in which mechanization has become a deciding factor, has created a demand for such labor out of all proportion to the normal requirements of industry. The change in the nature of product requirements with its concentrated and heavily increased demands for such items as aircraft, tanks, guns, shells, etc., has also completely upset the balance of types of skilled-labor requirements.

Many men highly skilled in their normal sphere of operations are now totally unsuitable without further training and experience for use on specialized operations essential to the production of munitions. The change in product has also made many existing machine tools redundant, and a huge program of machine-tool manufacture has in consequence had to be undertaken, the production of which has absorbed a large amount of highly skilled labor.

Much of the existing stock of tools and equipment suitable for the manufacture of normal products has become a frozen

asset due to its unsuitability for munitions production, while the change-over to munitions has created a demand for jigs, tools, gages, and equipment of a special nature which has had to be designed and manufactured in sufficient quantity to meet production requirements and to build up replacement stocks.

This program has placed an almost overwhelming load on the tool and equipment manufacturing organizations throughout the country, and has vastly increased their demands for the highest grades of skilled labor.

The mechanization of the fighting forces has also created a demand for skilled mechanics for the purpose of repair and maintenance of its mechanical equipment, and as the supply of such equipment increases so will the demand for labor for its repair and maintenance increase. The problem, for which a solution has to be found, is one of ever-increasing demands for skilled engineering labor with a totally inadequate supply from which it can be drawn.

Past experience proves that skilled labor can only be produced by going through a long course of training and practical application, and it is obvious that the time factor precludes any possibility of obtaining, by the use of normal methods of recruitment and training, any increase of the higher grades of skilled labor of sufficient magnitude to meet present requirements. . . . .

The objective should be to make the task fit the type of labor available rather than wait until labor is trained to a standard suitable to handle the ordinarily accepted layout of operations.

It is agreed that, according to the normal standards of industrial requirement, labor is graded to deal with the allotted tasks in a most efficient manner, and it therefore follows that without further drastic analysis and breakdown of operations with a view to simplification of tasks, the distribution of existing skilled-labor forces cannot be materially improved.

An important contribution to the problem of redistribution can, of course, be made by promoting or upgrading labor to perform tasks of a higher grade after a shorter period of experience than would normally be considered necessary.

This method does not, however, insure the full and efficient utilization of the acquired skill of operators, neither does it assist directly in the absorption of the available mass of untrained labor which must be regarded as the raw material of the labor-supply phase of industry. Nevertheless, such promotion and upgrading should be carried out to the fullest possible extent and can be regarded as a forcing ground for the production of labor capable of handling the higher-grade skilled operations.

The grade of labor allocated to any particular operation in the engineering industry is determined by the degree of skill necessary to the performance of some particular portion of that operation. Keen analysis of such operations will more often than not reveal possibilities of segregating those portions requiring a high degree of skill in performance, the remaining portion being such as can be carried out by operators of a lower degree of skill. This applies to practically all operations in the manufacture of engineering products but applies with particular emphasis to machining operations. Since the shortage of skilled labor is particularly acute in that field it is vitally necessary to insure, in so far as is practicable, that operations are split in such a way that the tasks assigned to the higher grades of skilled labor are appropriate to their skill and training.

It may be argued that the double or triple handling of a piece due to the splitting of operations means an increase in the number of man-hours taken to handle a given amount of product. In some cases this may be true, but it must be regarded as practicable to do so if a larger over-all output can be achieved owing to the absorption of additional labor of a lower degree of training and experience.

Experience has, however, proved that in many cases subdivision of operations has actually increased output from a given amount of plant and has also enabled lower-grade machinery to be used with maximum efficiency.

Machinery of a low-grade type unsuitable for finishing operations can be used for roughing and semifinishing operations, using much heavier feeds than would be practicable on machines which must be maintained in a suitable condition for carrying out precision finishing operations.

The subdivision of operations cannot be carried out successfully by haphazard methods, but must be subject to carefully planned analysis with a view to setting out the processes in a manner calculated to produce a series of graded tasks.

Efficient planning along these lines should produce task grading of the flow type by means of which it should be possible to absorb inexperienced labor for the simpler task and by easy stages of progression to bring it along through the semiskilled range until it is capable of carrying out the lower-grade skilled tasks. This method of operation planning simplifies the problem of tuition of trainee labor, and the provision of instructors for the purpose of giving such training, as existing labor with the assistance of toolsetters, chargehands, and foremen will be found capable of coaching labor through the simple stages of progression.

Existing operators capable of setting up their own machines can be rapidly upgraded to the rank of toolsetters and the breakdown of operations into simpler elements will be found to be of great assistance in this direction, and progress will be more rapid than would be the case if setups of a more complicated nature had to be made.

The centralized grinding of all tools and cutters should be planned and will be found to be the most economical and satisfactory method of tool maintenance. The policy of production simplification should be applied to all phases of production and such things as the provision of dummy setting pieces for roughing and semifinishing operations, when handling work of a repetitive nature, will be found advantageous and of great assistance in the quick resetting of tools.

It is also good practice in the case of upgrading of toolsetters to provide a sample finished workpiece to assist them in reading component-part drawings, and this will often avoid mistakes and scrap work.

The question of the provision of such aids to production simplification as special jigs, fixtures, tools, and gages need not be stressed, but even in this connection the carefully planned subdivision of operations can be of assistance. A jig or fixture for complicated operation may be of a costly nature both in money and in man-hours taken in its manufacture, but subdivision of the operation and the provision of simple jigs or fixtures to handle a section of the operation will, in the case of existing jigs, enable increased output to be obtained at a lower tool cost. In the case of new work it should simplify design and cheapen the manufacture of jigs and fixtures and at the same time enable labor of a lower grade to be used for the less important sections of the operation. It is, however, vital that due consideration be given to the provision of proper location and datum points when designing such a sequence, or the desired final accuracy of the product may be affected and the principle of simplification unjustifiably blamed for the error.

The problems of production executives in applying the process of simplification of manufacture are infinitely variable, depending upon the type of product and the volume in which it is to be produced; it would therefore serve no useful purpose to give details of particular applications in any field of engineering production technique. It can, however, be stated that the same fundamental principles apply whatever the product and whatever the volume of product may be.

Planned and coordinated action with a view to simplification of complex operations must inevitably simplify the problem of utilization and training of the abundant supply of untrained labor for the lower-grade tasks. It should also enable the existing skilled labor to be redistributed to handle a largely increased volume of production as such labor would only be used to carry out tasks to which such skill is essential.

The production principles enunciated are in everyday use in all engineering works to a greater or lesser degree, and the only divergence from existing practice now suggested is that operation simplification shall be carried out to a degree far in excess of what is necessary under ordinary industrial conditions, and that the absorption and training of unskilled labor shall be accelerated. Sound common sense, cooperation between labor and industry along the lines suggested, together with the training schemes of the Ministry of Labor, should go far toward solving the labor problems of the country.

Measuring Piston Temperatures

S.A.E. JOURNAL

An instrument for the continuous measurement of piston temperatures is described in an article by Arthur F. Underwood and A. A. Catlin, of the research laboratories division, General Motors Corporation, in the *S.A.E. Journal* for January, 1941.

The general methods of installing thermocouples in both the aluminum and cast-iron Diesel-engine pistons are shown in Fig. 1. Numerous variations of the installations shown have been used. Each design of piston has presented its own installation problems. It is imperative that the lead wires from the thermocouples be secured tautly to the piston to prevent

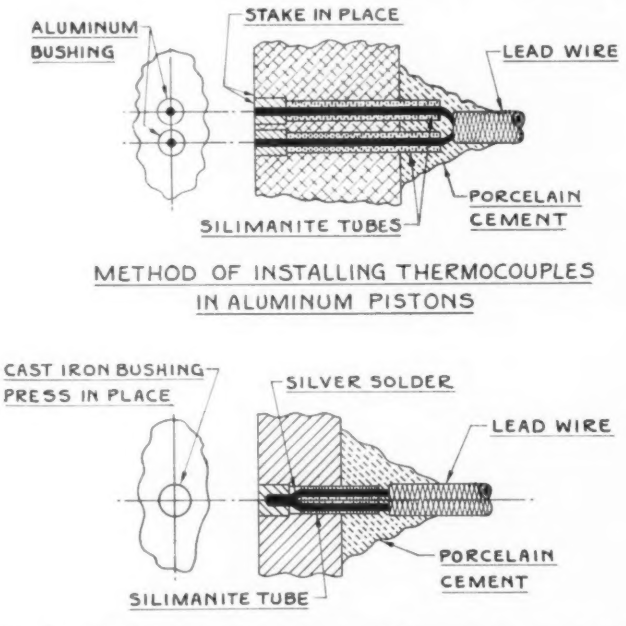


FIG. 1 METHOD OF INSTALLING THERMOCOUPLES IN ALUMINUM PISTONS (ABOVE) AND IN CAST-IRON PISTONS (BELOW) OF DIESEL ENGINES

them from fatiguing and causing an open circuit. They also must be well insulated. Cotton-covered enameled wire soon chafes through, causing a short circuit. Rubber insulation is likewise unsatisfactory even when covered with an impregnated cotton loom. The use of double "spaghetti" covering has been

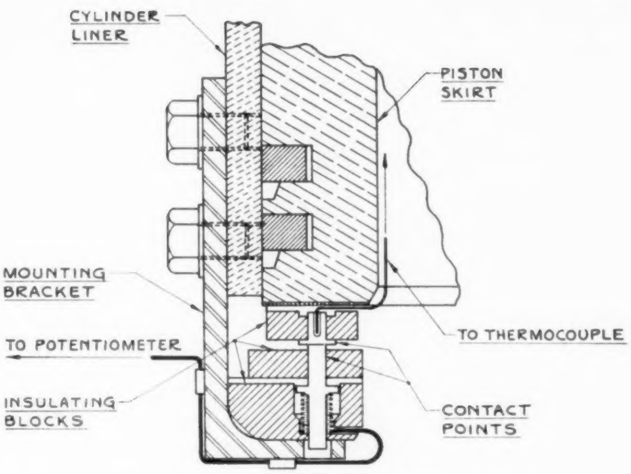


FIG. 2 PISTON THERMOCOUPLE CONTACTOR

quite satisfactory, but it chars readily at elevated temperatures. Surprisingly, the installation of the thermocouples has been the most troublesome part of this temperature-measuring scheme.

The contactor shown in Fig. 2 was used to complete the elec-

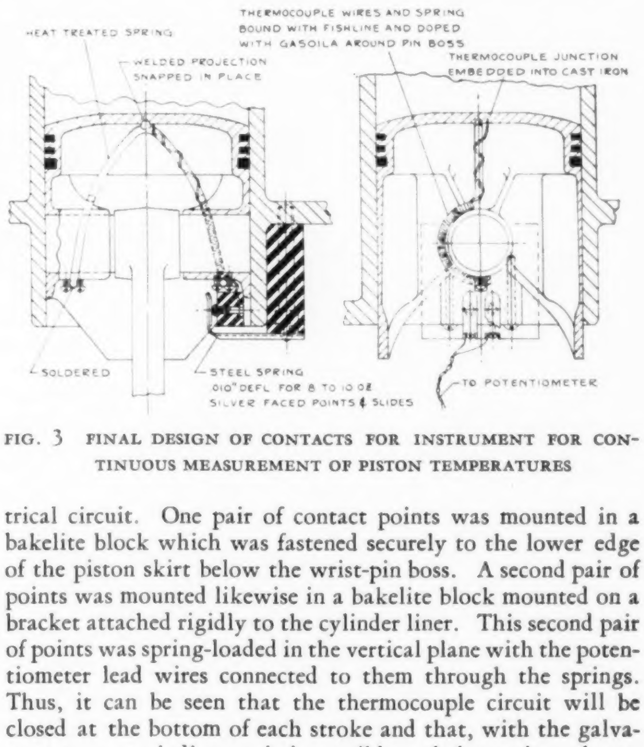


FIG. 3 FINAL DESIGN OF CONTACTS FOR INSTRUMENT FOR CONTINUOUS MEASUREMENT OF PISTON TEMPERATURES

trical circuit. One pair of contact points was mounted in a bakelite block which was fastened securely to the lower edge of the piston skirt below the wrist-pin boss. A second pair of points was mounted likewise in a bakelite block mounted on a bracket attached rigidly to the cylinder liner. This second pair of points was spring-loaded in the vertical plane with the potentiometer lead wires connected to them through the springs. Thus, it can be seen that the thermocouple circuit will be closed at the bottom of each stroke and that, with the galvanometer as an indicator, it is possible to balance the voltages and read the temperatures as in an ordinary arrangement.

To have a thoroughly practical instrument, it was proposed that one should be developed that would run 10,000 miles without attention. The first requirement was to remove the porcelain cement. Inquiry brought out the fact that a cement which would withstand the high temperature and be free from mineral filler could not be obtained; therefore, it seemed best to remove the thermocouple wire from the hot piston surface so that an ordinary gasket cement could be used. Secondly, the life of the contacts would have to be extended.

The final design is shown in Fig. 3. By use of the "wishbone" supports made of spring wire and snapped into place, the thermocouple wire is led away from the hot piston head. It has been the practice to wind the thermocouple wires around

the steel wire, lash with fish line, and cement together with a gasket cement such as "gasoila." The "wishbone" also can be made of tubing and the thermocouple wires led down the center. To fill the core with cement, a vacuum is applied to one end of the tube. Of course, the location in which it is desired to place the thermocouple will determine the actual shape of the "wishbone."

A silver alloy, Elkonium No. 1, has been found to be perfectly suited for the contacts. This material is furnished as contact points and in strips $^1/_4 \times 6 \times 0.030$ in. The points are pressed into holes drilled at the ends of the bolts which go through the insulating block on the piston. A soft solder is used to "sweat" the slides to the heat-treated steel spring. All wire connections must be soldered thoroughly.

The steel springs are made to have a deflection of 0.010 in. with an 8 to 10-oz pull at the center of the sliding surface. It has been found that this rate gives a spring that has long contact life and that has no undesirable vibration period. Dimensions of the spring will depend on the particular application which may require a longer or shorter length.

For speeds up to 4000 rpm, a contact angle of 70–80 deg of crankshaft rotation has been used. In the case of a $3^3/_4$-in-stroke engine, this amounts to a sliding contact on the silver strip of about $^3/_8$ in.

A production engine fitted with this setup has been run 25,000 miles at 60 mph on a dynamometer with no attention or adjustments, thereby demonstrating the endurance and practicability of the device. Several laboratory test engines also have been equipped with the apparatus for investigating piston design up to 4000 rpm and for fuel study. A test car has shown that measurements can be made continuously on the road.

Power and Combustion

THE INSTITUTION OF MECHANICAL ENGINEERS

THE twenty-seventh Thomas Hawksley Lecture of The Institution of Mechanical Engineers, "Power and Combustion," was delivered by A. C. G. Egerton, professor of chemical technology, Imperial College of Science and Technology, South Kensington, and secretary, the Royal Society, on November 15, 1940.

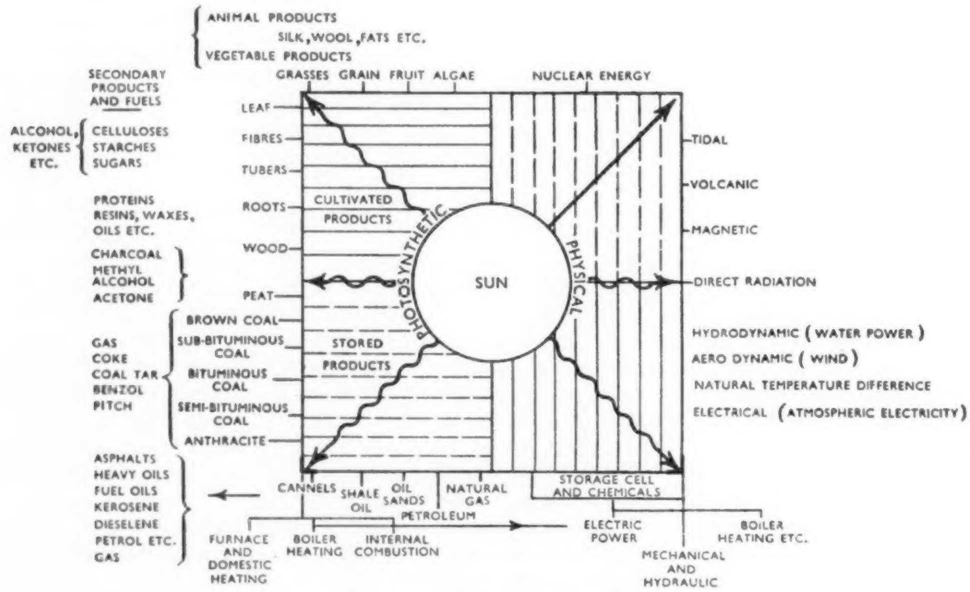


FIG. 4 VARIOUS SOURCES OF POWER

TABLE 1 SOURCES OF POWER

	Power, hp
Solar radiation	5×10^{23}
Solar radiation received by earth's outer atmosphere	2.3×10^{14}
"Effective inflow" of solar radiation	1.3×10^{14}
Power dissipated by tides	1.5×10^{9}
Power dissipated by lightning	From 1×10^{9} to 2×10^{8}
Rough estimate of power corresponding to radiant energy assimilated to plant life	3×10^{10} (?)
Power corresponding to present rate of use of coal and oil	2.0×10^{9}
Estimated potential hydroelectric power[a]	3.2×10^{8}

[a] Converted from total calories used per annum. The world production of electric power (1927) has been estimated as 3.10^7 hp. The world's available electric power, if all the coal and oil won were used for its generation, was estimated as 2.2×10^8 hp.

Professor Egerton's first task is to examine and discuss the sources of power which he eventually summarizes in Table 1 and presents diagrammatically in Fig. 4. This is followed by a section on combustion.

In his summary, Professor Egerton says:

At the beginning of this lecture the various ways in which power was derived from the sun were discussed, and the measure was taken of the power which is at present used. Before ending we will look at one more diagram, Fig. 5.

We came to the conclusion that for the whole world the total mechanical work performed by the manual worker and by his horses and his oxen is not much less than the total amount of power generated from the burning of fuel and from water power. This work is performed at the expense of energy of foodstuffs got by agriculture (i.e., through photosynthesis). The human being eats on the average quite twenty times the energy in the form of food that he performs as work. One worker on the land, however, can produce (on the average in Great Britain) food enough for ten, so producing food alone the population could go on increasing to a limit which would depend on the area and productivity of the soil. If fuels are also won, metals can be got and goods can be manufactured and sold in exchange for food, and the population can grow still further. The food-fuel cycle is the very basis of our material economy. The object of fuels is twofold, to provide warmth and to supplement human labor.

In Fig. 5 the endeavor is made to summarize human activity. Starting from the center, solar radiation provides stored products and cultivated products. The energy value of the foods produced would be less than one tenth that of the total fuel produced, but the gold value of the foodstuffs is far greater than the value of all the other production. More than three quarters of the total gold value of the world's production is represented by food. According to the figures quoted in Sir H. Hartley's Mather Lecture (1937), 88 per cent of the cultural production is for food and fodder, and 12 per cent for manufactured products such as textiles, etc. In the case of the primary products which are not cultivated, 57 per cent of their value is for fuel.

The food products provide energy to the worker, fuels supplement his work, thereby upgrading, as it were, the energy in order that exchange may be made for food, the energy of which is more highly prized. Food products also are converted or broken down to simpler products. The total value of the cultivated products used in industry is only about half that of the "upgraded" products, made with the aid of fuel.

The energy of the food is downgraded in the process of keeping the mechanism of the body in action. Efficiency—and by that one means, making the best use of what the sun affords us—depends not only on the efficiency of the "upgrading" process, but also on the "downgrading," the health and efficiency of the worker. Overfeeding and bad nutrition are wasteful even as is bad organization in the machine shop, or a smoky chimney.

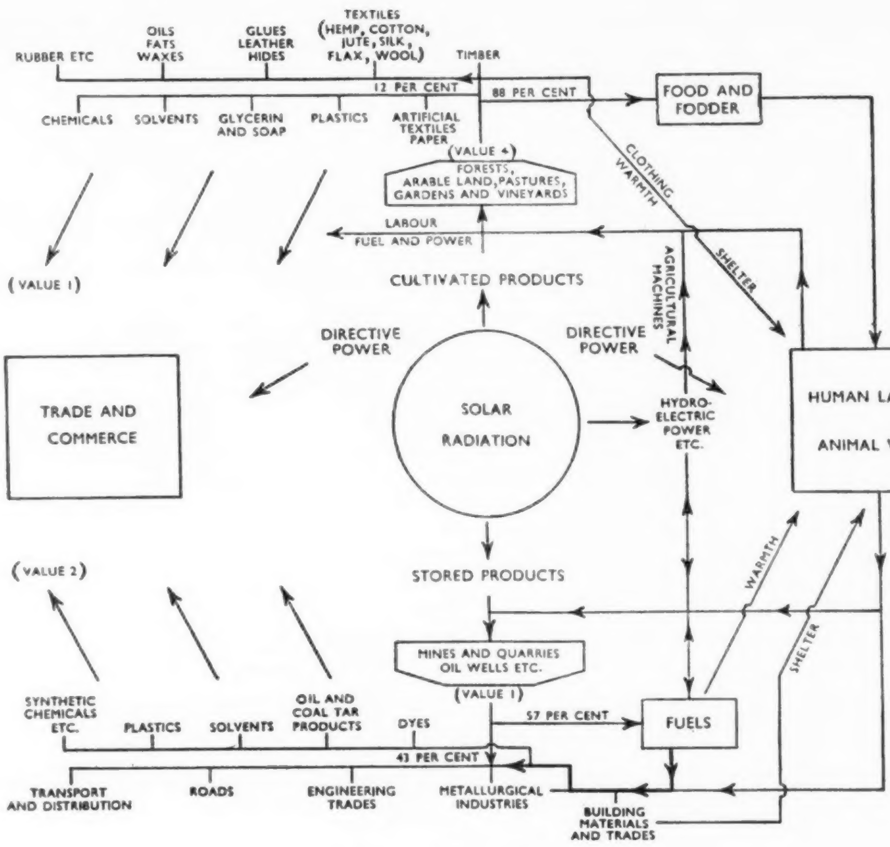


FIG. 5 DIAGRAM OF HUMAN ACTIVITIES

Besides food and water, clothing, shelter, warmth, and rent are essentials to life, and to this could be added light and transport. Some of these essentials are got through fuels, some through treatment of agricultural products. In some cases it is more suitable to break down the agricultural product, in other cases to build up from the fuel—for instance, alcohol made from cracked gases from oil now competes with fermentation alcohol. Acetone, as a by-product from the oil industry or carbide industry, has replaced acetone as a by-product of wood distillation. To build up a food from coal is not yet an economic proposition, and I doubt whether it would ever conduce to happiness. In tilling the land, in riding the seas, there is happiness eternal, and there can be no general prosperity so long as agriculture as a whole is depressed.

A fuel is unnecessary (except in providing warmth) unless it is helping to supplement human labor, if it takes more labor to win the fuel than that which it can supplement, it is not worth the winning, and therefore a basically uneconomic process.

It has been suggested that the price of wheat should be controlled internationally; the yield of wheat per acre taken the world over is nearly constant, and yet its price fluctuates exceedingly, and production becomes completely out of balance with consumption. This whole question has been closely studied in a recent book by P. de Hevesy, "World Wheat Planning." Wheat is the key food. Economists might consider, too, some control of the primary fuels. With control of these two factors, the material economy of the world might be run much more smoothly than it has been in the past, and freedom and competition could be allowed in all other activities. It cannot be right that the world's store should be ravaged by the most active thief, who gets to the shelves after murderous assaults. It is also clear that as much power as possible should be derived from the riches that the sun showers on us continually—60,000 times as much as the energy we at present use—rather than by depleting our inherited stores so fast. It seems to me that in our present economy insufficient difference is drawn between using up real irreplaceable capital and the replaceable products which the sun showers on the earth.

It is with the object of drawing attention to these matters that I have tried to sketch in some perspective the fundamental facts and figures upon which our material existence depends. Admittedly many of the figures are only rough estimates, but if they incite others to delve deeper and get the basis of our material economy more accurately assessed, I shall be happy in my mistakes. There will come a time, and I hope soon, when we must needs look to the future.

"Father of the Cyclotron"

SCIENCE

AT a dinner of the American Physical Society and Section B of the American Association for the Advancement of Science, the Duddell Medal of the Physical Society of London was presented to Ernest Lawrence, "physicist, engineer, team leader, good colleague, Comstock Prizeman, Nobel Laureate," as he was designated by Prof. R. H. Fowler, of the University of Cambridge, who delivered the address, "Professor Lawrence and the Development of the Cyclotron." Professor Fowler closed his address, reported in *Science*, Jan. 24, 1941, with the following words:

We hail Lawrence, therefore, as one of the great toolmakers of our time for his gift to us of the cyclotron. Looking back as a physicist, or if you prefer more strictly as an atomic physicist, over the years within my own experience, I can think of

few new tools of comparable importance primarily developed by one individual. The cloud chamber of C. T. R. Wilson is certainly one, and perhaps the mass spectrograph of Astor. Other great tools, for example, optical and X-ray spectrographs, have been from the first the work of many independent hands. But when one contemplates the wide fields which are coming to depend on the cyclotron one is tempted to believe that it will prove to be *the* great tool of our times. Incidentally, to be frivolous for a moment, it is the one major tool of which, to my knowledge, the Cavendish Laboratory ever made a Chinese copy.

A great toolmaker is a high estate, but we should do Lawrence scant justice if we did not hail him as a great team leader too. He has inspired and driven a remarkable team of workers—in these days in enterprises of such magnitude and complication the power to organize such cooperative efforts and to get the best from a team is an essential quality in the outstanding physicist. At least one major discovery is credited in the Cavendish to the toe of Rutherford's boot. I fancy that Lawrence's boot has an equally good toe and have no doubt that he uses it with judgment—I hope with equal success—as the great team leader must.

The English-speaking democracies may well contemplate with some pride the part that their outstanding scientific leaders have played in building modern science, and not least that wing of the building devoted to physics and engineering—which physicists, chemists, engineers, and an odd mathematician or two have combined to glorify. Each of us will have our own pet list of heroes in this group. All these lists will be different and I shall not invite criticism by giving you mine. But I think we shall all soon agree that on this list the father of the cyclotron will hold an honored place.

Electrocoated Pile Fabrics

INDUSTRIAL AND ENGINEERING CHEMISTRY

THE electrostatic process as applied to the manufacture of pile fabrics was described by N. E. Oglesby and L. E. Hoogstoel, of the Behr-Manning Corporation, Troy, N. Y., in an article that appeared in the December, 1940, issue of *Industrial and Engineering Chemistry*.

According to the authors, success of the process in sandpaper manufacture indicated its possible usefulness in textiles. The method is illustrated schematically in Fig. 6.

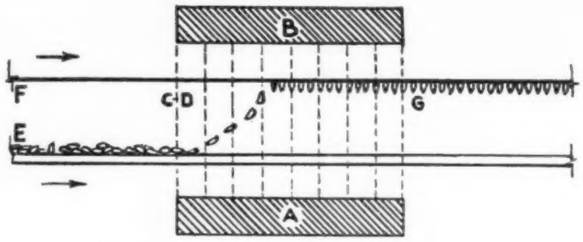


FIG. 6 ELECTRODE ARRANGEMENT FOR ELECTROCOATING SAND PAPER

A Negative electrode
B Positive electrode
C, D Lines of electrical force
E Conveyer belt carrying loose grain
F Paper with glue side down
G Abrasive grain embedded vertically in glued surface

An adhesively coated backing is fed continuously between a pair of electrodes, *A* and *B*, with the backing adjacent to the upper electrode and with the adhesively coated side facing downward. Abrasive grains are fed between the electrodes by a continuously moving belt which travels adjacent to the lower electrode *A*, with the grain on the belt facing the adhesively coated backing. One electrode is grounded while the other is connected to a source of high potential. The potential is usually of the order of 10,000 to 25,000 volts per cm of electrode spacing. The abrasive grains are charged with the sign of the bottom electrode, stand erect with their long axes parallel to the lines of force between the two electrodes, and, when sufficiently charged, are propelled to the adhesively coated backing sheet and are embedded in the adhesive with their long axes perpendicular to the backing sheet. Furthermore, since the grains are charged with the same sign, they repel one another and are for this reason uniformly distributed on the backing sheet.

In coating textile fabrics one of two methods is used—a pulsating or interrupted direct potential, or an alternating potential. Of the two, the latter is preferred. Under the influence of an alternating potential the sign of the charge on the electrodes and on the particles is repeatedly reversed so that the particles bound backward and forward between the electrodes without "treeing" and becoming inactive as is the case where an unvarying unidirectional potential is impressed upon the electrodes.

There is an important difference between abrasive grains and textile fibers. Abrasive grains are dense, nonabsorbent, and relatively unaffected by moisture. Textile fibers, on the other hand, may absorb large quantities of water and vary decidedly in their electrical characteristics, depending upon their water content. Successful coating of pile fabrics by the electrostatic method, therefore, requires that there be reasonable control of the water content of the textile fibers. Furthermore, as in all textile work, it is desirable that there be some control of humidity.

In order to obtain good coatings of highest density and uniformity of appearance, the textile fibers should be cut to uniform lengths. This is a sizable development in itself. Furthermore, aside from the effect on density of coating, the cutting of the fibers to uniform length is more economical than subsequently shearing nonuniform coated fibers to obtain a level pile surface effect. Control of uniformity of cut is attained by repeated testing during the cutting operation which consists in making distribution curves of the fibers as cut.

The first commercial use of the electrocoating process in the formation of pile fibers was in the manufacture of dress goods sold under the name "Fibredown." In running goods of the Fibredown type the adhesive is applied with a stencil or other means in the form of the pattern desired, the fibers are electrostatically propelled into the adhesive, and the adhesive is cured in conventional festoons. A number of fibers may be used—for instance, cotton or rayon. As previously pointed out, they are cut to uniform length before the coating operations, and may be either dyed or undyed. So far, Fibredown has been sold with white fibers only, but an assortment of colors will be offered at an early date.

The adhesive development was an important part of the problem. Dress goods of the type under consideration must be able to stand either reasonable laundering or dry cleaning, and repeated ironing. That the adhesive should stand reasonable laundering is quite a rigid specification, but that it must stand normal ironing without appreciable loss of loft or color makes the task doubly difficult. Since white patterns are very popular, initial color and color retention of both the fiber and the adhesive are of primary importance. A number of desirable adhesives are automatically eliminated because they are thermoplastic and cannot be subjected to the normal ironing operation. Since a number of patents covering the whole development are still pending, a number of the details of the process cannot be disclosed. In general, however, certain synthetic resins have been found to be the most desirable bases for adhesive compositions.

Pendulum Dampers

THE INSTITUTION OF MECHANICAL ENGINEERS

IN AN extensive paper by Z. W. Zdanowich and T. S. Wilson entitled "The Elements of Pendulum Dampers," to be found in the June, 1940, issue of the Proceedings of The Institution of Mechanical Engineers, the dynamics of a pendulum damper is treated in a more general way than heretofore, all known types being included. A new method of considering the effects of a pendulum damper when fixed at any point in an engine system is developed, showing that its action results in an alteration or displacement of the critical speeds at which the harmonic orders occur.

A convenient method is outlined for arriving theoretically at the best design for a pendulum damper, whatever may be its location in the engine system. As a practical illustration, a brief account is given of experimental work which was undertaken to test the behavior of a well-known engine when a certain pendulum damper was fitted to the flywheel. A further account of a similar application to a six-cylinder engine is also given. Special forms of pendulums, and a note on the estimation of angular amplitudes, are discussed in an appendix, and a bibliography and a short list of the most important patent specifications relating to pendulum dampers are also included.

Measuring Instruments

INSTITUTION OF PRODUCTION ENGINEERS

A REVIEW of modern measuring instruments and the principles of their design appear in an article by Dr. Geo. Schlesinger, member A.S.M.E., director of research, in the *Journal* of the Institution of Production Engineers, England.

The review considers the refinements of fits and limits, the possibility of accurate measurement, the character and range of the necessary instruments, direct reading and estimation of fractions of divisions, and the formulas for calculating the degree of magnification. The measuring system may be based on:

1 Mechanical means, involving the use of a screw, lever, gear, or spirit level.

2 Optical means, employing one or more lenses for the purposes of magnification. Instruments in this group include the optical comparator, the ultraoptimeter, the projector, the telescope and target, the telescope and collimator, and the autocollimator, with block reflector and optical square.

3 Microcomparator gages comprising mechanical optical apparatus, electrolimit gages, the photocell Precizer, the pneumatic micrometer.

4 Methods of "active" calibration.

There is a tendency nowadays, says Dr. Schlesinger, to avoid the separation of machining and measuring, and to combine the controls for the cutting tool or grinding wheel with the measuring apparatus, in order to relieve the operator of responsibility for size. This is a very important development, and the result is achieved in practice by the use of a diamond feeler, or photocell, or by controlling the cutting tool directly from a gage or fixed standard incorporated in the machine. The automatic guidance of the wheel in combination with its adjustment or resharpening, using diamonds, renders it possible to make the most important grinding machine automatic and capable of being operated by a girl after a short period of instruction. Thread grinding, gear grinding, spline grinding—all complicated and difficult operations—are performed today by semiskilled male or female operators with a degree of accuracy as regards dimensions and surface finish which was unheard of until recently.

Tools and gages, jigs and fixtures, the first sample, and single pieces, however, require the services of skilled operators today more than ever before. Such men can never be replaced, but in modern manufacturing plants precision machines, correctly set up, equipped with suitable cutting tools and measuring apparatus, and controlled by semiskilled or unskilled operators, suffice to insure interchangeable products. An indispensable condition is the continuous control of accuracy in the machine tool itself.

I.M.E. Coat of Arms

THE INSTITUTION OF MECHANICAL ENGINEERS

REPRODUCED on this page is the Coat of Arms of The Institution of Mechanical Engineers, reproduced from the frontispiece of the *Journal*, November, 1940. According to a note in the same issue, the symbolism of the design is briefly as follows:

On the shield a device signifying the art of measurement and accuracy of workmanship; as the crest controlled power dominating the world, typified by a heraldic horse chained to the globe from a coronet which is itself a symbol of a chartered body; lastly as supporters (to which the Institution is entitled as a chartered body) a representation of Archimedes appears on the left to signify science and of Vulcan on the right to signify craftsmanship. The word "Progress" appearing below the shield has been used by the Institution on various of its devices and at different times since it was founded.

I.M.E. COAT OF ARMS

COMMENTS ON PAPERS

Including Letters From Readers on Miscellaneous Subjects

Resources and National Defense

Comment by Ralph E. Flanders[1]

This stimulating paper[2] by John P. Ferris and Howard Emerson raises fundamental issues relating to the methods by which our agricultural, industrial, and transportation practices shall be adjusted to the changing conditions of natural resources and industrial techniques.

The distinction between exhaustible and recurring resources is, of course, fundamental. The primitive natural cycle was based on recurring resources, our present technology is largely based on the use of exhaustible resources, and the time is coming when we will be forced again to place our chief reliance on recurring resources.

There are at least three ways of making readjustments. The natural way of doing it is to continue with an older technology until it becomes no longer profitable. We are then forced to take the necessary steps to shift to newer methods. So far as relates to natural resources, this means that when they have been exhausted to the point where they are too expensive to use, we will develop substitutes for them. This method requires the least degree of planning and initiative.

The other extreme is that of endeavoring to foresee in advance what are to be the tight spots of the future, and to make the shift in techniques before exhaustion of resources by present method makes that shift imperative. Practically by definition, this means that the shift will have to be made before it is an immediate economic necessity. This further means that the shift will have to be socially subsidized as is the case, on the whole, with the interesting work being done in the Tennessee Valley where an important local experiment is being carried out with the support of the resources of the whole nation.

The third method is intermediate between the two. It relates to a subsidizing, not of the change itself, but of the study of the general situation and of the best means of meeting it when, as, and if it occurs. This, if done successfully, may make the change one which can be accomplished less expensively and more quickly than would be the case if it were left without planned guidance. There is also the possibility that such subsidized investigation may turn up possibilities of making the change from exhaustible to recurring resources at a profit much earlier in the process of exhaustion than would be the case if the situation had not been examined. There are doubtless some examples of this sort to be found in the TVA situation.

To sum up, it is my belief that the first, or rough-and-ready way of not shifting until we have to, will not necessarily be calamitous, though it is not the best way of doing it. The other extreme of subsidizing a shift before it is economically necessary, it would seem, can only be done on a small scale and not universally. If the whole country were a TVA, TVA would be much less possible because there would be no outside support to subsidize it. The intermediate method of subsidizing examination and research in the fields which are approaching the critical situation seems to me to be by all means the most desirable solution.

[1] President, Jones & Lamson Machine Co., Springfield, Vt. Past-president A.S.M.E.

[2] "Resources and National Defense," by John P. Ferris and Howard Emerson, Mechanical Engineering, vol. 62, no. 11, November, 1940, pp. 809–812.

Comment by Donald Comer[3]

The facts set forth in this article should be made available to the readers of the agricultural as well as the engineering periodicals. Had they been widely known a hundred years ago and in consequence put into practice, our country, particularly the cotton belt, would present a very different problem, and be a very different place.

I for one deeply appreciate the setting forth in a manner comprehensible to the lay mind of these deeply significant and compelling truths and of the timely warnings they convey.

Comment by W. H. Jasspon[4]

I am very much interested in the proposal advanced by Mr. Ferris and Mr. Emerson in the article entitled "Resources and National Defense." In my judgment the increasing use of recurring raw materials, and new uses for them, may represent a partial solution, not only to our surplus-land problem but also to our surplus-supply-of-labor problem.

We have been faced by the necessity of restricting agricultural land use and creating an additional burden of unemployed labor as the result, plus the contribution to this debility by the increasing introduction of farm machinery in agriculture. It therefore becomes a major rather than a minor problem to create new markets for the products of the fields and forests. The TVA and other institutions of this character which are able to carry on research must continue and expand their activities. Obviously the engineer and scientist are the prime motivating influences in this kind of work.

[3] Chairman of the Board, Avondale Mills, Birmingham, Ala.

[4] President, Perkins Oil Company, Memphis, Tennessee.

Comment by Elmer Torok[5]

The paper "Resources and National Defense" covers a great problem of our industrial preparation, not only for defense but also for the future course of our man-harnessed industries. Does it not bring to the mind of the reader the thought that trends in the directions outlined will help solve not only our industrial problems of the future but will develop work for everybody in the conversion of industry into a different cycle? A transition of industrial activities from the use and consumption of *exhaustible* resources to a full utilization of the known *recurring* resources will involve the utilization of many, at present idle, man-hours; and there is ever the thought that the maintenance of industrial evolution into the cycle will continue to utilize the human forces that nature has given us. Nature is omnipotent, and the use of natural resources, without attempting to exhaust them, can be thought of only as the way nature intended.

Comment by Walter Rautenstrauch[6]

This paper points out clearly the need for more fundamental organization of our

[5] Power Superintendent, North American Rayon Corporation, Elizabethton, Tennessee.

[6] Professor of Industrial Engineering, Columbia University, New York, N. Y. Mem. A.S.M.E.

national economy in which the engineer will be permitted to represent the interests of society in the conservation and use of our natural resources. The present emergency demanding accelerated use of our natural resources focuses attention not only on the present problem but upon the future trend of our national economy. The excellent examples and illustrations of the ways in which engineers may deal with the problem of our natural resources clearly emphasize the importance of this problem. As I see the issues involved in the questions raised in this paper, the most important is how can the service of the engineer be integrated in the organization and management of our national economy in order that he may fulfill his declared purpose to develop the arts and sciences for the service of mankind.

The members of our engineering societies have been addressing themselves to detailed technical problems, and the great problems of the national plant as a whole have received scant consideration. This paper calls attention to the need for intelligent planning in the use of our natural resources. Immediately all the high priests of private enterprise will lift their voices in opposition, with the probability that the voice of the engineer will be drowned out. Unless the engineering societies come to grips with the forces operating in our economy which prevent our using our intelligence they are violating their trusteeship of the national interest.

COMMENT BY WALTER N. POLAKOV[7]

The paper by Messrs. Ferris and Emerson treats of the timely and grave problem confronting our country. Its significance stands out particularly on the background of our momentous task of preparedness.

Their fundamental proposition is that we have two types of sources of energy: replenishable or "recurring" and exhaustible. From this they derive a doctrine which may be restated thus: In order to introduce sanity into our energy economy and thereby prevent the reversal of the human race to a savage level of economy, we must substitute wherever and whenever possible the recurring energy sources for the exhaustible.

The thesis of the authors is woven around energy consumption in the production of certain essential materials and indicates their preference for the use of hydroelectric energy as it is a recurring source of power.

I deem it important to cast a glance into the field of "exhaustible" energy sources both because hydroelectric supply and the discovery of other "recurring" energy sources are either too limited for the nation as a whole or are not immediately available. How then are we going to meet our energy demand in this power age of ours and how are we going to bridge over the transition period from reckless depletion of our fuel deposits to the planned reproduction of the recurring energy sources?

Of our total energy consumption, that derived from water power is not over 4 per cent. The rest is derived from coal, natural gas, and petroleum—all exhaustible sources. Yet, at the current rates of consumption, the known sources of petroleum would last some 12 to 15 years, natural gas 30 to 35 years, while coal, upward of 6000 years.

Obviously, any sane planning must first conserve the quickly exhaustible sources. Next, any sound engineering planning of our energy economy must take into account the existing power-generating equipment and specific properties of exhaustible fuels. Thus, the prime function of natural gas is that of being recirculated into petroleum wells to increase the recovery of petroleum. Next, it should be remembered that lampblack—for the time being the essential ingredient of rubber products—is best derived from natural gas. Therefore, the uses of natural gas must be restricted to these two activities and the rest conserved for the maximum number of years.

Similarly, petroleum products are primarily used as motor fuel, illuminants, and lubricants. Until the motor fuel will be successfully derived from vegetable substances, it is imperative to restrict the use of gasoline to national-defense purposes (army, navy, aviation), to the manufacture of lubricants needed for high-speed machinery, and to promote, with subsidies if necessary, both research and construction of liquefaction plants and multiple by-product coal plants.

COMMENT BY ERNST BERL[8]

I was very much interested in the great importance of phosphorous compounds. I believe this important role concerning the fixation of nitrogen results only by using legume plants, because the bacteria which live on those plants can with a rather slow process convert atmospheric nitrogen into nitrogen compounds which can be assimilated by plants. If my recollection is right, this is true for only that special kind of plants, and other plants are not in a position to activate atmospheric nitrogen. In those cases the amount of nitrogen which is removed with the harvested plants has to be replaced by nitrogen-containing fertilizers because the amount of ammonia nitrite-containing substances in the atmosphere coming down with rain is not sufficient to cover the needs of the soil. Certainly, the law of minimum established 100 years ago by Justus Liebig is right, that those three important fertilizers—phosphates, nitrogen, and potassium compounds—have to be present to a certain minimum degree, otherwise, plants could not grow in the right way.

The work which was recently discussed in addresses before the American Association of Petroleum Geologists and before the American Chemical Society has been mentioned. I think that under the present conditions in the United States only substances containing carbohydrates with practically no value could be successfully converted into solid or liquid conversion products which contain little or no bound oxygen (bituminous coals, asphalts, and oils). It may be of some interest to know that we can produce a mixture of liquid hydrocarbons composed of aromatic, aliphatic, and hydroaromatic hydrocarbons with a yield of a little more than 40 per cent based on the carbon content in the carbohydrates.

COMMENT BY W. HARRY VAUGHAN[9]

The article by John P. Ferris and Howard Emerson of the Tennessee Valley Authority makes some excellent modernized engineering points in conformity with the old Baconian dictum: "To command Nature, you must first understand her laws, and obey them." I am sorry the authors chose to put their topic sentence so near the end of the article, "The engineer, as a member of a profession which aspires to utilize the forces of nature for the benefit of man, assumes an obligation to make his individual decisions conform with sound, long-time strategy wherever and whenever possible."

It appears to me that the authors are suffering somewhat from the limitation of a journal which purports to deal only in applied physics. It seems they are looking for economic and technical catalysts which will allow us to tap as many earth-surface recurring natural cycles as possible to yield energy and materials economically in one form or another for the benefit of man without materially reducing this possibility for our descendants.

No doubt those scientists who are optimistic over the future of the discovery

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[8] Research Professor, Carnegie Institute of Technology, Pittsburgh, Pa.

[9] Director of the State Engineering Experiment Station and Head of the Department of Ceramic Engineering, Georgia School of Technology, Atlanta, Ga.

and release of new deposits of materials and new sources of energy now unknown will challenge the authors' thesis as being narrow in concept. This need not worry them as it is important for the engineer to work with the laws of nature in the most effective manner known at any given time.

Though I am optimistic for the future of science and its opportunity to make man more and more independent of nature and its natural cycles, the engineer must proceed upon established facts at the moment, guided by a philosophy which raises one eye to the probable conditions of the future. Until such time as the scientist can turn over to the engineer some hint of ways and means to obtain atomic energy on a cost-plus basis, the authors have expressed some worthwhile principles, which, in my opinion, should actuate many more engineers in their everyday recommendations and procedures.

Correction and Authors' Comments

The authors first wish to correct and amplify a statement which appeared in their article "Resources and National Defense" in the section headed "Energy From Soils" on page 811 of the November issue.

It was pointed out that in addition to being a major source of industrial raw materials, soils through crops were a source of energy and that by improving soil fertility we could expand our potential-energy supply. As an illustration, it was stated that "one bushel of corn, if fed to a working animal, will make available 80 horsepower-hours of net mechanical energy."[10] This statement is true in the sense that 80 horsepower-hours of energy is recovered by the animal from the bushel of corn. Use of this figure in a comparison with other sources of energy was incorrect, however, since the 80 hp-hr is not all useful energy. In order to find the actual mechanical work done, in pulling a wagon for instance, deductions must be made for work involved in action of internal organs and in moving the animal's body. In this case, the one bushel of corn would result in about 24 hp-hr of work, representing an over-all efficiency of 15 per cent. If the more normal ration of hay, corn, and oats were used instead of corn alone, the efficiency would be only 9 per cent.[11]

As a matter of interest, the authors compared the cost of energy to be obtained from electricity with the cost of the same amount of energy from corn. The foregoing correction, which measures the energy in terms of useful work, changes the result in favor of electricity as the cheaper source. A similar comparison would show an immediate dollars-and-cents advantage for gasoline on the basis of energy costs.

However, for a large percentage of American farmers, especially those on small farms, there are many other considerations which favor the retention of work animals as their basic source of power, supplemented by tractors or electric power equipment for peak jobs and special tasks. The farmer who becomes completely dependent upon outside sources of energy supply frequently gets into serious economic trouble when crop prices fall to the point where he has no cash to buy fuel. Another great danger to be weighed by the farmer in each case is whether power-driven equipment may not tend to perpetuate excessive cash cropping to pay for the equipment, instead of the type of farming which conserves soil and builds security.

In this discussion, it should be borne in mind that in their present uses, crops, as recurrent sources of energy, are consumed only as animal and human foods, and so are limited to supplying a relatively small percentage of our total energy.

For 1929 energy from recurrent supplies—food, draft animals, firewood, and water power—has been estimated as on the order of 15 per cent of the total sources of energy used in this country. In the same year recurrent sources—agriculture and forests—supplied over 70 per cent in terms of value of the raw materials of United States industries.[12]

With these considerations in mind and after reading the contributed comments, the authors suggest that there is no sweeping conclusion which can be drawn; each source of raw materials or energy requires separate consideration. The method of research is the first step toward the gradual substitution of less exhaustible for more exhaustible sources of supply. But it is only the beginning because research workers are not usually the men who make policy decisions; it is mainly farmers, businessmen, and engineers who determine the actual effects of research upon our economy. If they neglect to act on the conclusions which science presents to them, we will continue to follow what Mr. Flanders calls "the rough-and-ready way of not shifting until we have to." As Mr. Comer suggests, this way has been pretty near calamitous in the South.

Perhaps the original article should have stressed the strides which have already been made by scientists, engineers, and business leaders in cutting down waste in extracting exhaustible raw materials from the earth and improving the efficiency of their conversion into useful products. Where lower costs result, this trend will no doubt continue. It is in those cases where immediate economic advantages do not coincide with considerations of long-time defense of national security that problems arise. At this point the authors have one final conviction, which is that ways can be found under the democratic process to take steps necessary to such defense, that we should not have to turn to a dictatorship form of government to build up and conserve the resources on which our civilization is based.

Machine-Tool Castings

Comment by P. S. Lane[13]

This paper[14] illustrates the fact that microstructure, rather than hardness and chemical analysis, often determines the quality of a casting. The data submitted by the author include studies of castings on which actual field performance is known, and these field results appear to substantiate his microscopic and wear-test evidence.

During the last few years, the writer has devoted considerable time to the study of the effects of microstructure on wear and surface mutilation. Most of this work has been in connection with internal-combustion engines, particularly cylinders and piston rings. While the speeds and loads encountered in engines are different from those in machine tools, it has been found that the "primary-ferrite" formations are also very undesirable for friction surfaces. Due to heat and load conditions in high-speed gasoline and Diesel engines, the cylinder surfaces are often quite dry and structures of the type shown in Fig. 1 of the paper have been prone to scuffing and seizure.

It should also be stated, however, that some cast-iron structures, having the fine nodular graphite, even though free of the ferrite-fine constituent, show evidence of wearing away at a relatively rapid rate. Hence, it might be suspected that the fine-cluster graphite, rather than the ferrite itself, is mainly responsible for the scoring and galling tendency. In one 10-in. Diesel engine, using fine-grain cast-iron liners of 240 Bhn, with nodular graphite,

[10] Based on data in "Feeds and Feeding," by F. B. Morrison (twentieth edition, 1936), p. 50.

[11] Ibid., p. 429.

[12] U. S. Census Publication, "Materials Used in Manufactures: 1929."

[13] Research Engineer, Muskegon Piston Ring Company, Muskegon, Mich.

[14] "Making Better Machine-Tool Castings," by F. J. Dost, Mechanical Engineering, May, 1940, pp. 365–369.

the wear was at the rate of 0.006 in. per 1000 hr running. Replacement liners of 180 Bhn, but with a coarse flake-graphite structure, and with higher phosphorus, wore only 0.002 in. per 1000 hr under the same operating conditions. This experience illustrates the unreliability of using Brinell hardness alone in predicting resistance to wear.

Fig. 2, *A* and *B*, in the paper is a type of structure which often gives good wear performance, providing that unit loading is not too high, and that spring qualities are not essential. The structures shown in Fig. 2 *C* and *D* are considered less desirable. In Fig. 3 *C* and *D*, such iron, while wearing away rather rapidly, often does so with complete freedom from galling or seizure actions, even though having a ferrite matrix.

It should be remembered that wear resistance of any material is not an inherent quality except in a very general way. Many factors of service environment can alter, and sometimes reverse, results. Usually, we are interested in the wear performance of two mutually rubbing surfaces, so that a condition of "compatibility" must be maintained. In both wear testing and in actual service, four basic points must normally be considered:

1 The wear or "change in dimension" of the sample.

2 The wear or "change in dimension" of the surface against which the sample rubs or slides.

3 The "surface condition" of the sample, i.e., scoring, scuffing, galling.

4 The "surface condition" as in item 3, for the opposite rubbing surface.

In the control and regulation of foundry practice, to keep resultant structures within the range where optimum wear performance is obtained (as indicated by tests and experience), the section thickness or cooling rate is a potent factor. This may in some instances be regulated by means of ladle additions or "inoculation." It would seem that additions having a carbide stabilizing action, such as chromium or molybdenum, would prove most beneficial. The author mentions the fact that his graphite and ferrosilicon treatments restrict the abnormal structure to the skin or outside surface, limiting it to a depth of $^1/_{32}$ to $^5/_{32}$ in. In light castings which are production-machined with an over-all finish of less than $^1/_{32}$ in., the obvious goal would be to eliminate entirely the undesirable ferrite formation. The fact that some castings are practically free of the primary-ferrite structure makes this attainment seem possible, particularly as more knowledge is acquired of its mechanism of formation.

COMMENT BY A. C. DENISON[15]

This paper, while short, contains important information which adds greatly to the understanding of proper gray irons for machine tools. It is evident that in the recent past there has been too quick an acceptance of low-carbon high-tensile fine-grained irons as the hoped-for perfect iron for machine-tool building, without realization of other factors which might be important.

Such fundamental work as that done by the author, in the direction of interpreting and understanding observations which are the result of practical experience, carries the industry a long step forward toward the goal of the ultimate product.

So far as the writer knows, this is the first time that scoring and galling have been definitely traced to "primary or eutectic ferrite;" which information is of great importance both to the users and producers of fine gray irons. The understanding of this phenomenon should encourage engineers to a wider use of these finer irons in machine design because with this understanding a more adequate specification of gray irons should be developed to meet the requirements, together with better controlled foundry operations for the same purpose. Thus, confidence in these modern gray irons as a good engineering material should be increased.

This paper also shows that following poorly founded customs sometimes leads us astray. For, after all, we have judged gray irons too long solely on the basis of tensile strengths and fine grain alone. As the authorities indicate there might better be a broader engineering conception of other desirable properties of gray iron to correlate with tensile strength and fine grain, such as resilience, damping, machinability, and microstructure. These properties should all be considered when thinking in terms of the finest gray irons for machine tools.

Recently, in a lecture in Cleveland, Professor Schneidewind, of the University of Michigan, before the American Society of Metals mentioned that flake graphite and not nodular graphite in gray iron gave the best all-around product and that gray iron with flake graphite had far superior wear-resistant properties. It is to be noted that his statements check with the findings of the author. Furthermore there was an interesting comment made by Professor Schneidewind that this flake-graphite structure seemed most readily a product of cupola melting which is also something worth noting, particularly if there is an inclination to believe that this old and economical method of melting is becoming obsolete.

COMMENT BY R. SCHNEIDEWIND[16]

The author has performed an important service by bringing the subject matter of this paper, which is metallurgical, to the attention of mechanical engineers, since wear resistance is largely involved with microstructure. All of the work with which the writer is familiar at the University and in industry fully confirms the author's findings.

It is the writer's feeling, however, that the nodular appearance of some of the graphite particles is due to the fact that the polisher has used the wrong abrasive. A different abrasive would show these areas to contain very fine flakes of graphite. The author is quite correct in pointing out that the presence of ferrite promotes galling. We have found that his method of seeding or deoxidation is quite successful in eliminating primary ferrite and eutectiform graphite. In the case of heavier castings, it is sometimes found advisable also to add a carbide stabilizer. This stabilizer will prevent the heaviest section from becoming weak. Many foundries, for example, which use nickel to prevent chill and in refining graphite, will balance the nickel with chromium so that the composition will have 1.5 nickel and 0.5 per cent chromium. It is the writer's belief that considerable improvement in wear resistance of cast-iron parts can be effected by control and specification of the microstructure of the wearing surface.

COMMENT BY J. S. VANICK[17]

The 10,000 chemical analyses which form the background of research of this paper represent a laboratory expenditure of $25,000; and it is apparent that this work has not been done in vain. It is evident that the machine-tool industry regards a single failure of a machine tool as one too many. It is comforting to feel that the origin of the difficulty had been traced and had been eliminated through a normal working period so that, when urgent demands came upon the industry, it was able to proceed without being delayed.

As the author points out, castings of 10 years ago or earlier were made of higher-carbon, lower-silicon irons. When these mixtures were adjusted to make the light sections machinable, the heavy sections were open-grained or failed to develop a

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[16] Professor of Mechanical Engineering, University of Michigan, Ann Arbor, Mich.

[17] Metallurgist, Development and Research Division, The International Nickel Company, Inc., New York, N. Y.

fine finish. Machine-tool castings usually vary widely in section. An unequal rate of cooling of thick and thin parts causes warpage, due to corresponding inequalities in structure, unless such inequalities are evened out through carefully balanced compositions alloyed to maintain uniformity. Nickel came into use prominently at that time as an alloy addition to cast iron because it was known to refine the coarser flake-graphite grain and stabilize the pearlite, thus reducing the difference in hardness between thin and thick sections and achieving a uniformity in structure. By using irons particularly fitted to produce a close-grained but flaky graphite structure in a pearlitic matrix in the heavy sections, such as the tables and ways of machine tools, it also became possible by alloying with nickel to produce a similar structure (or conversely eliminate mottled structures) in the thinner sections. This assisted the machinability of surfaces of these thin sections as well as contributed to the extinction of microstructural gradients which might produce excessive distortion due to casting stresses in such large castings as machine-tool beds.

The effects which brought on the galling problems were caused by a normal desire to build improvements into machine-tool cast irons, and the usual mixtures were changed to produce stronger and stiffer irons with the gap in the difference between the structure of cast iron and steel constantly becoming narrower. Steel running against steel is much more susceptible to galling than cast irons running against each other. Previously, structures and surfaces susceptible to galling, such as occur in Fig. 2 of the paper, were rare and, as the author points out, structures of the Fig. 3 type with flake graphite instead of the powdery forms were common. The powdery graphite or supercooled structures might escape detection in the fracture test or other mechanical tests upon the iron or both.

The poor structures were caused by a combination of circumstances which could be associated with the ingredients of the charge, the melting practice, metal-handling and molding practice, or conditions of the mold, including gating-and-pouring practice. Preventatives consist of returning part way to the less susceptible mixtures and cupola ingredients, or adding antidotes, or changing molding, gating, and pouring practice where possible, or doing all of these things. These poor-structure irons are usually produced by employing increasing quantities of steel in the cupola or melting very hot, or cooling fast. The normal higher carbon, lower silicon irons drifted into low-carbon high-silicon types which are much more susceptible to supercooling effects and the consequent development of a galling-susceptible structure containing powdery graphite.

The higher freezing temperature and the lesser quantity of dissolved carbon produced a much more sluggish urge to graphitize. This supercooled liquid iron was similar in chemistry to soda-water solution containing a large quota of solute or carbon dioxide, which can be quickly released by adding a drop of "promoter," which sets off a proportionate reaction. Years ago Coyle,[18] in working upon the Ni-Tensyl process found that nickel aided by an addition of concentrated silicon yielded a degree of graphitization out of proportion to the result achieved when these same elements were melted down as original material in the cupola charge. In some cases such additions recently have been termed "late silicon" additions. They serve to unbalance the apparently stable supercooled solution and set off or promote a multiplicity of microscopic reactions in the freezing liquid which give birth to graphite nuclei. These nuclei have a chance to grow by diffusion and to further the reaction through the establishment of microscopic carbon-concentration gradients, which further unbalance the supercooling effects. By timing these treatments the tendency is to form normal flaked graphite. Since this reaction might go too far, it is prevented from doing so by the solvent power of the nickel-iron solution for pearlitic carbon. In the presence of nickel, the reaction would regularly stop at the pearlite concentration of carbon, and yield in the solid, when the metal was cold, a structure of normal graphite flakes embedded in a pearlitic or sorbitic body. The small amount of nickel would not be sufficient to cause any hardening above that of the parent composition. These principles put into practice today are continued with the drift back again toward the higher carbon, lower silicon irons, which are less sensitive to the melting process in the foundry and, therefore, less likely to

[18] U. S. Patent No. 1,867,732.

FIG. 1 MACHINED EDGE, SHOWING EXTREMELY FINE PEARLITIC MATRIX

(Center of casting was of a similar structure; ×500.)

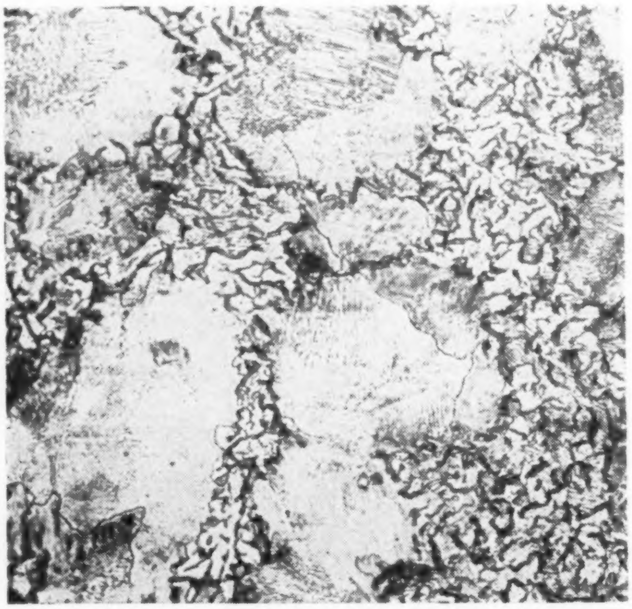

FIG. 2 CAST EDGE, GRAPHITE-FERRITE AREAS IN EUTECTIC PATTERN DISTRIBUTED IN A FINE PEARLITIC MATRIX

(4 per cent nital etch; ×500.)

supercool and produce powdery graphite structures, such as appear in Fig. 2 of the paper.

The use of (1) less steel; (2) less superheat; (3) deoxidizers and inoculants; (4) pearlite stabilizing alloys summarizes most of the present correctives. It may be inconvenient or impossible to correct a fifth factor, i.e., fast (surface) cooling. When it prevails, it may cause a supercooled structure on the cast surface which, by pouring hot, can be controlled and reduced in depth to less than $^1/_{16}$ in. This small amount would normally be removed in the rough-machining cut on the cast surface; Figs. 1 and 2 of this discussion illustrate this occurrence.

The work in this paper throws considerable light upon the reasons why certain irons equal in hardness to good wearing irons fail to do their work. More than 10 years ago the following comments were expressed in an article on the wear and machinability of cast iron by T. H. Wickenden:[19]

"Much discussion can be found in the literature regarding the relative wearing properties of hard and soft irons. Numerous examples have been cited in which a soft iron has shown better wearing properties than a hard iron under certain conditions. This fact may be regarded as a real news item, for the opposite is the usual occurrence and does not cause unusual comment. From this state of affairs the conclusion may be deduced that hardness alone is not necessarily a true index of the durability of cast iron but must be considered in conjunction with other characteristics, such as are revealed by the microstructure of the iron."

This observation indicated long ago that the microstructure was extremely important as a factor in determining the wear resistance of cast iron. There is an important difference between the wearing rate of a structure susceptible to galling and the normal rate of wear in a structure that is resistant to galling. The relative merit of the structures in Figs. 1 and 2 of the paper, in the matter of resistance to wear, has only been established in a qualitative sense. The poor structures are worn away far more rapidly than a normal rate, and the degree of merit between different types of good structures has not been clearly established. The difference may be so great that the tests reported in this paper and shown in Fig. 5 merely indicate qualitatively that a structure susceptible to galling may produce a rate of wear which is destructive enough to make the machine practically useless. In the data which are reported in Fig. 5, the irons showing the lesser rate of wear and possessing good structures should continue to improve their resistance to wear as the matrix is maintained in a fine pearlitic condition with normal graphite flakes or, as a higher order of hardness is developed in this pearlitic structure without producing the powdery or dendritic graphite. It is known that this can be done with a specification similar to the one following, accompanied by proper alloying and processing procedure in the foundry:

	Per cent
Total carbon	3.1–3.4
Silicon	1.0–2.0
Manganese	0.6–1.0
Sulphur and phosphorus	Normal
Nickel	1.0–1.5
Chromium or molybdenum	Up to 0.3
Brinell hardness:	
Saddles, carriages, etc	180–220
Ways, etc	200–240

Nickel additions in this case are intended to maintain the normal good machining hardness in the light sections, and dense structure of the material in the heavy sections. The very fine pearlitic structure of a nickel-alloyed iron has a low wearing rate and it is not readily susceptible to galling. Actual metal loss by wear proceeds at an extremely low rate in the case of machine tools where sliding loads are lighter and move more slowly than they do in engines. There

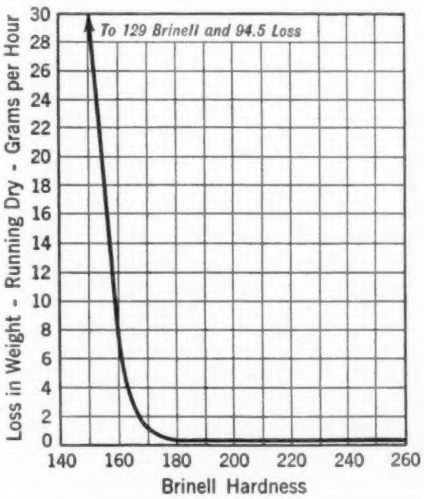

FIG. 3 RELATION OF BRINELL HARDNESS TO WEAR OF CAST IRON AGAINST ITSELF

are available ample data from the automotive industry, where the wear problems have been studied, to show that moderately harder irons resist wear longer. A typical wear-resistance test curve on engine irons of increasing hardness appears in Fig. 3 of this discussion. If higher hardnesses are needed to resist wear further, such upper hardness levels can be readily achieved by holding to the established pearlitic flake-graphite-base structure and building up the hardness of such moderate-carbon low-silicon irons by making approximately balanced additions of nickel with chromium or molybdenum to the desired hardness level. In such cases, the graphite flake may be somewhat finer and the pearlite moving toward harder sorbitic structures, while the hardness and resistance to wear are moderately raised.

The builder of machine tools has become accustomed to employ the best of materials designed to make tools last indefinitely without trouble to their owners and operators. In having full access to all of the necessary raw materials and in making expenditures for research, such as this to establish experience, his products have established a leading position in world markets. The author should be congratulated for presenting before the metal-making as well as metal-working industries this record of experience and achievement.

Improvements in Technical Education

COMMENT BY CARROLL D. BILLMYER[20]

I am indeed glad that an engineer with such a reputation as Mr. Carrier's calls attention to the undesirable features now in vogue in undergraduate engineering curricula. Many of us have held like opinions, but lacked the weight to have them listened to. His paper[21] should be called to the attention of all college presidents concerned. They and not the deans of engineering are frequently to be blamed for the conditions he enumerates.

I would like to add to his list one more criticism. The tendency to compress essential courses beyond reason and to stress memorization at the expense of reasoning is often due to an ill-advised attempt to provide room in the curricula for an excessive number of so-called elective courses. I do not think the average youngster is able to make proper selections. Then why handicap his future for the sake of what Mr. Willkie would call a "candy stick" educational policy?

The author's remarks about the entire educational system are very apt, and should be called to the attention of the National Education Association. We shall never get balanced curricula until our high schools are brought into line.

[19] "Data on Machinability and Wear of Cast Iron," by T. H. Wickenden, *S.A.E. Journal*, vol. 22, Feb., 1928, pp. 206–212.

[20] Assistant Professor of Mechanical Engineering, Rhode Island State College, Kingston, R. I. Mem. A.S.M.E.

[21] "The Employer Suggests Needed Improvements in Our System of Technical Education," by W. H. Carrier, MECHANICAL ENGINEERING, vol. 62, no. 10, October, 1940, pp. 712–714.

Humanistic subjects should be included in every engineering curriculum, but should they be elective? The author refers to the S.P.E.E. Committee report on page 727 of the same issue, the concluding paragraphs of which summarize the situation so well.

COMMENT BY GEORGE L. SULLIVAN[22]

I read Mr. Carrier's article with a great deal of interest and profit. It is a valuable experience for the educator to read the reactions of the employer. It helps him to visualize the environment for which he is trying to prepare his students. I find however, that many years' experience in teaching and in industry, during which time I have had to use and to pay engineering graduates, causes me to question some of the statements in this paper.

No one can object to Mr. Carrier's views on the objectives of education, but I think his views on the way these objectives can be attained illustrate common errors among employers. These errors have two sources: First, the employer is inclined to think of the student as raw material which the teacher should be able to shape as he wishes. Instead, each student is a complex, growing individual. Each student is different from every other student; there is no such thing as producing interchangeable parts. Employers are so used to seeing the same shaped boss on every casting from the same pattern that they expect every student from a given college to be like every other student from that college.

The second error that an employer is apt to make is to assume that the engineering graduate is a finished product when he comes to him. The engineering graduate is like a growing fruit tree. The college has nurtured and tended him for four or more years, he has reached the stage of growth where he should soon bear fruit. The employer then takes over. Nearly every employer will tell you he wants a graduate with initiative and originality. When he gets him, what does he do? He puts him at a desk, on a drawing board, or in a laboratory where every detail of his work is standardized to the last iota. After about five years of this he is given a job requiring some choice of action. The employer then complains that the engineering college turns out men of no initiative. He forgets that he has been stunting the initiative ability of the man for five years. As educators, some employers are good manufacturers.

If we examine the five features that are criticized we will find that each feature may be justified.

1 *Specialization*. Every book on educational psychology that I have read lists interest as a powerful incentive to effective study. If a student is interested in aviation the wise educator will use that interest to promote the education of that student. The student who is interested in aviation will learn much more about the fundamentals of the mechanics of fluids if he has a wind tunnel to work on than if he doesn't. What matter if after graduation he applies these fundamentals to the problem of driving air through ventilating ducts?

2 *Selection*. Perhaps it is our fault, but there just isn't any way of accurately grading the abilities of high-school students. There are a few students of whom we can say, "There is no doubt of his high abilities." Of a few others we can say, "There is no doubt that he lacks required abilities." There is no way accurately to grade the great number of borderline cases. Mr. Carrier suggests the "intelligence-test" type of examination. Psychologists do not agree even on the definition of "intelligence." The difficulty is evidenced by the hundreds of diverse tests which are recommended and used. Mr. Carrier says, "The employer can obtain some idea of the personality of the student from an interview." Can he? In a recent test of employers' ability to rate applicants there was only about four per cent more agreement than there is in pure chance. In a group of 57 applicants for a particular job one was rated all the way from best to poorest by a group of twelve employers. (Laird, "Psychology of Selecting Employees," page 101.)

3 *Understanding*. The wisest man on earth does not have a complete understanding of anything. Mr. Carrier says, "In engineering education, the aim should be to have no fact or theory accepted until it is first thoroughly understood." Since we do not "thoroughly" understand anything we should not accept anything? I doubt if Mr. Carrier would say that he "thoroughly" understood the theories of air conditioning twenty years ago, yet he accepted them and applied them to the best of his understanding with valuable results. The desirability of "understanding," of "thinking," and of "reasoning" and the uselessness of "mere" factual knowledge are constantly emphasized. Facts are the things we understand, the things we think about, the things we reason with. Facts have a very important place in education. After all, "understanding" of a theory, or of anything else, is nothing but the possession of facts about that thing. The man who had all the facts pertaining to anything would understand that thing. These facts of course include reasons and relations and not merely unrelated ideas.

Mr. Carrier suggests that "the student should be encouraged and required to do everything for himself that he can accomplish through his own mental processes without recourse to text or oral instruction." I think no educational psychologist would agree to this. It seems to me that it would be equivalent to an employer's telling a new employee that he must not look at any company drawings or catalogs or ask anyone a question about anything but must figure everything out from fundamentals. Experienced educators advocate just the opposite; that a student be encouraged to get all possible information on his subject from his teacher, from books, from experience, and from every other available source. Then he should be encouraged to carry the investigation further into unexplored fields.

Mr. Carrier also says that the best teachers should teach the freshmen and sophomores. The best executives of a company do not act as foremen in order to get the work in a factory properly started. The best teacher executives supervise and direct the work of the younger teachers and encourage and guide the upperclassmen.

4 *Personality*. Most engineering teachers agree on the importance of "personality." They try to develop personality. The reason that grades are given in technical work and not in personality, honesty, cheerfulness, judgment, cooperativeness, and such other qualities is that we have a measure for ability in technical work but we have no method of quantitatively measuring personality. It is said that few engineers lose their jobs because of lack of technical ability. My investigations indicate that a more accurate statement is that "few engineers lose their jobs for any reason except lack of work." Many engineers become dissatisfied and quit and many are laid off because there is no work for them but few are fired when there is work.

5 *Student Grading*. A student has many abilities, not one ability. For many of these abilities there are no tests and no way of expressing them quantitatively if they could be measured. Secondly, there are many employers, not one employer. I have talked with many employers and have yet to find one who could tell me in specific terms what he wanted. He wants a man who can think, yes. But how good a thinker? How well must he understand? There are nearly as many desirabilities as there are employers.

That educators do not feel that their

[22] Dean, College of Engineering, University of Santa Clara, Santa Clara, Calif. Mem. A.S.M.E.

work is perfect is indicated by the critical discussions at faculty meetings and at meetings of the Society for the Promotion of Engineering Education but the demand for engineering graduates indicates that the product is fairly satisfactory. Just yesterday I received a letter, a long-distance phone call and a personal visit all asking for engineering graduates. I had no unemployed to fill the requests.

I believe, and I think most engineering educators agree with me, that our biggest handicap is scarcity of students with outstanding natural abilities. I do not know what to do about this.

AUTHOR'S CLOSURE

Since the great majority of comments that I have received, both directly and indirectly, on this article as well as on a previous article appearing in the May, 1937, issue of MECHANICAL ENGINEERING, "Principles Versus Curriculum in Memorizing Facts and Theories," have been in agreement, it is refreshing to find an educator of prominence who apparently disagrees totally with all the specific principles emphasized in these papers. Such, I understand, is the attitude of Dean Sullivan. However, I suspect that Dean Sullivan may have somewhat overstated his case in a natural zeal for debate.

In the first place, before examining his specific criticisms, I wish to protest the inference of Dean Sullivan that the employer is much less intelligent than the college professor. The position he takes with reference to the qualifications of employers to pass upon the education qualifications of their technical employees probably would apply fairly well thirty or forty years ago. I believe I can inform Dean Sullivan authoritatively that this stricture does not generally apply today. The leading employers today are either college men themselves or employ college men in the qualification of their engineering employees.

My associates among the employers with whom I have conversed are men of exceptional attainments as well as men of college education, and are not at all to be classed in the category of the antediluvian type of employer referred to by Dean Sullivan. Most of these men believe that their own college training could have been greatly improved, as they now look back upon it, and in some cases they speak of their success as being in spite of their college training rather than because of it. This may not be wholly just, but I am stating their reactions. There are many men, however, both employees and employers, who attribute the inspiration leading to their success to some incident while in college—more particularly the inspirational teaching of some one professor. It is interesting to note that where such impetus was given, it was largely *without* the curriculum, which emphasizes the fact that successful teaching cannot be wholly mechanized. One inspirational teacher in a college course, whether it be in physics, mathematics, engineering, or humanities, accomplishes more for good and for a sound approach than all of the rest of the instruction in the curriculum put together.

Dean Sullivan says, "As educators, some employers are good manufacturers." This is a rather broad and, I believe, largely unwarranted stricture. I might turn this around and say, as educators, some technical-college deans and presidents are good manufacturers, for that is about the attitude a few of them seem to take toward education—manufacturers interested in the quantity rather than the quality of their product, n "window dressing" in the form of equipment and curricula comprising a multitude of specialized undergraduate courses rather than in true education. College alumni, employees as well as employers, sense this trend.

Let us now examine the five features of which Dean Sullivan says criticism may be justified.

1 *Specialization.* Dean Sullivan starts with a major premise, with which I heartily agree, that "interest (is) a powerful incentive to effective study." He makes the assumption, however, that interest can best be aroused by specialization and in this he makes a complete "about face" from the classical school of educators to the extreme "progressive" school where all teaching is conducted by this method. Extremes do not work too well in anything. Interest in fundamental engineering and physical principles should be inspired by copious practical illustration, but should not be confined to one type of application nor should the principle itself be lost sight of by the student in his admiration for the machine or process.

I was unfortunate enough, while in college, to take one specialized elective and it was a lot of "rubbish" and to the best of my observations so is much of the so-called undergraduate specialization of today. I admit that a lot could be gotten out of it if it were made a means to an end, but the trouble is it is rarely, if ever, so taught. Actually, most such courses seem to present an amazing number of (to the student) unrelated and inconsequential facts. They had better spend their time reading "pulp wood" novels. These would be less demoralizing to the student's mind.

We then also come to the neck of the bottle in undergraduate education and that is *time.* It has been repeatedly demonstrated that in a four-year course the undergraduate, unless he is an intellectual genius, cannot specialize and at the same time acquire the necessary related fundamentals needed in engineering, nor can he acquire a sound educational background. I do not decry specialization if the fundamentals have been mastered, but to do a good job in most of our colleges, this requires the greater part of four years. Specialization should come largely in the fifth and sixth years. Furthermore, a student cannot specialize *effectively* until he has a thorough engineering background. Except where specialization has been made in a five-year course, it is of practically no value to the employer.

There are many highly important things that should be crowded into the undergraduate education, if possible, to the exclusion of many technical specialized electives. These are, to name a few, better training in English and public speaking, economics and the principles of accounting, practical sociology and the psychology of human behavior, but time does not allow all of this, however desirable. We only have time to hit high spots in these fields. Certainly, time needed in this field should not be pre-empted by technical electives, nor should any of these things be allowed to interfere with the program of thorough education in the subjects taught. It is far better to teach less but teach it well.

2 *Selection.* In spite of what Dean Sullivan says, I believe there are some of our colleges, of high standing, which permit entrance through general examinations which are designed to test the student's intellectual ability. Intelligence must not be confounded with learning or even with educational training. I think intelligence is reasonably easy to detect in spite of Dean Sullivan's citations. The student who does not show ability both in mathematics and physics has no place in an engineering course. He may go to a trade school where he will be much better off. Some of our colleges should really be trade schools and not colleges. Much of what I have to say regarding both selection and specialization does not apply to the trade school.

3 *Understanding.* Dean Sullivan takes the position that complete understanding is impossible. Of course, I agree with him. There are many things beyond our reach which we must accept as premises. We cannot understand the ultimates of the universe—gravity, electrons, etc.—but we can understand their apparent laws, as for example, $V^2 = 2\,gh$. This may be accepted as a fact by the student and re-

peated like a parrot, or it may be thoroughly understood up to the cause of the gravitational force. It is surely a fallacious argument that because the ultimates cannot be understood that that is an excuse for not thoroughly understanding their laws. Most "muddle-headedness," so prevalent, is founded in this lack of thorough understanding. More particularly it is founded in an ingrained habit of the acceptance of things without understanding. *In so far as our schools are attempting to teach facts without understanding, just so far they are encouraging habits of mental slothfulness which lead to "muddle-headedness."* We gloss over with a veneer of learning and try to make it pass as education. I suppose there are many who do not distinguish between learning and education. A monkey or a parrot can become learned in so far as tricks are concerned, but they cannot be educated so as to invent tricks of their own. Some of our methods of instruction remind me of those we use in teaching tricks to animals. These practices are the antithesis of true education. There is such a thing as a learned fool.

4 *Personality.* I think there is but little disagreement here. Often the reason for lack of promotion and the loss of jobs in depression times is that the man with the best personality is the first to be promoted and the last to be laid off, everything else being reasonably equal. Men are actually discharged or allowed to become dissatisfied owing to lack of promotion whenever they have unfortunate personalities which do not permit full cooperation with their associates, or render them available for supervision of the work of others. It was never proposed to give marks for personality, but every engineering educational institution should stress to the students the importance of personality and guide them in its development.

5 *Student Grading.* In many respects the question of student grading is of lesser importance than other matters, but tests for purposes of grading should be divided into two separate parts: First, and more essential, the understanding of principles; and, second, their specific knowledge as well as their aptitude in speed and accuracy of engineering calculations. I believe that the standards for passing should be different as well as separate for these two departments.

In general, there should be a higher standard of ability required for entrance into engineering courses and greater stress should be placed upon the teaching of all fundamentals, as well as upon the educational approach in the teaching of subjects. I grant that it is impossible to carry out all that might be desired in education. There are limitations of both time and educational cost which make it impractical to do more than approach toward a better and more desirable type of educational program than that found in many of our technical colleges today.

W. H. CARRIER.[23]

Pulverized-Coal Development

COMMENT BY E. G. BAILEY[24]

The writer had very close contacts with John Anderson during the development period of pulverized coal in Milwaukee.[25] This contact was largely relating to metering and combustion control equipment, and he is, therefore, in a position to concur with the authors that a great deal of credit is due to Mr. Anderson and his associates for this early development. Among his associates, Fred Dornbrook should be mentioned particularly as the one in direct charge of operations who was most helpful in supporting Mr. Anderson. He actually carried out the many details which were so essential to the successful application of the system to steam boilers under conditions somewhat different from those which had prevailed in the cement industry where success also had been achieved.

Like many other developments of this kind, it was necessary to try out similar installations in other plants. This was done with a fair degree of success in several locations where other varieties of coal were used. Many of these, particularly the one at Cahokia, clearly indicated the importance of the quantity and character of ash in the coal.

Following Cahokia, there were other modifications and a larger number of installations, i.e., at St. Louis, Buffalo, Toronto Station, State Line, Deepwater, and elsewhere. In these, the refractory furnace gave way to water-cooled furnaces. Direct firing was developed to replace the bin, and the ash was removed in many cases in liquid form. Later, and more recently, two-stage furnaces have been developed and boilers with substantially no tube banks, such as the open-pass unit at the West End Station in Cincinnati.

This rapid growth and these modifications, resulting from experience, have built upon the Milwaukee experience and developed the art of burning coal in pulverized form to its present state of high efficiency, so that today approximately 90 per cent of recent steam-generating equipment burns coal in pulverized form and operates at high ratings and with a high degree of reliability.

COMMENT BY T. A. MARSH[26]

One of the authors requested that the writer defend the position taken relative to pulverized coal at a meeting 20 years ago. At that meeting, and at many other meetings during those promotional days of pulverized coal, the writer's question was invariably: "What becomes of the ash?"

Pulverized coal was promoted forcibly over a period during the early 1920's. The writer was associated with a stoker company adversely affected by the inroads of pulverized coal. This company also marketed ash-handling systems. The question, "What becomes of the ash?" was only as commercial as its competitive product, pulverized coal.

Fortunately, those were the days of business combinations. The stoker company was absorbed by a company manufacturing pulverized-coal equipment, and the writer had the pleasure of participating in many major pulverized-fuel installations, and had to meet this problem at first hand.

Neither the suits resulting from fly-ash discharge nor the later rigid city ordinances were anticipated at the time of the discussion, nor did the writer foresee the large industry that would be built up in the field of fly-ash entrapment. Pulverized coal has served its field well, but the question, "What becomes of the ash?" is still a very pertinent one.

COMMENT BY J. F. MCLAUGHLIN[27]

The authors have given an interesting history of the development of pulverized coal in Milwaukee. The results of the various investigations seem to confirm the conclusions arrived at by Mr. Dornbrook, in his paper, "Development of a Major Principle in Pulverized-Coal Firing," the principal conclusion of which was that, "in order to prevent ash from sticking to the inside surfaces of any furnace, these surfaces must be designed to cool properly the ash below its plastic state." This condition has been obtained by decreasing the Btu release per hour

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[24] Vice-President, The Babcock & Wilcox Company, New York, N. Y. Mem. A.S.M.E.

[25] "Milwaukee's Contribution to Pulverized-Coal Development," by H. Kreisinger and J. Blizard, MECHANICAL ENGINEERING, vol. 62, October, 1940, pp. 723–726, 737.

[26] Engineer, Iron Fireman Manufacturing Company, Cincinnati, Ohio.

[27] Mechanical Engineer, Iowa Power & Light Company, Des Moines, Iowa. Mem. A.S.M.E.

per square foot of furnace heat-absorbing surface to around 70,500.

The new unit at Des Moines Power Station No. 2, which is operated at 1340 psi 925 F and is tangentially fired, using Iowa coal of 9200 to 9500 Btu per lb with ash-fusion temperature of 1925 F, has a Btu release per hour per square foot of furnace surface of 105,000 at full-load rating. Hand lancing of the furnace and superheater is necessary.

There is some question whether the tangential method of firing, due to the bombardment of the heavier ash particles on the walls, might still cause slag to stick to the walls, even though the heat release was the same or lower than the Milwaukee furnaces where the overhead method of firing is used.

The writer would be interested, and is sure others would be, in Mr. Kreisinger's comments on this question.

AUTHOR'S CLOSURE

Mr. McLaughlin asks the question whether with the tangential firing, due to the bombardment of heavy ash particles on the wall, more slag would not be deposited on the walls than with the vertical firing even if the rate of heat release were the same. This question is brought up by the comparison of operating experience obtained on the Des Moines tangentially fired furnace with the operating experience obtained on the vertically fired furnaces of Milwaukee, particularly the furnace at Port Washington.

In the absence of comparable operating results it is difficult to answer the question convincingly. Comparison of the operating results of the Des Moines installation with the Port Washington operating results is deceiving because the rate of heat release, the coal, and the design of the two units are different in the two installations.

The heat release in the Des Moines unit is 105,000 Btu per sq ft of furnace water-cooled surface with a steam output of 325,000 lb per hour. With an average heat value of the coal of 9350 Btu per lb, 11.2 lb of coal containing 1.96 lb of ash is burned per sq ft of the water-cooled furnace surface.

The heat release at the Port Washington unit is 70,500 Btu per sq ft of water-cooled and steam-cooled surface with a steam output of 690,000 lb per hour. With coal having 12,900 Btu per lb, 5.46 lb of coal containing 0.68 lb of ash are burned per sq ft of water-cooled furnace surface. Thus, the Des Moines installation has about three times as much ash per sq ft of water-cooled furnace surface as the Port Washington installation. This much larger quantity of ash combined with about 300 F lower ash-fusion temperature and higher furnace temperature due to higher heat release accounts for much of the hand-lancing of the furnace water-cooled surfaces of the Des Moines installation.

Similar causes account for the necessity of hand lancing of the Des Moines superheater. The effective furnace volume is 15,700 cu ft. The total heat release is close to 400 million Btu at a steam output of 325,000 lb per hour, making the rate of heat release about 25,200 Btu per cu ft of furnace volume. To release this amount of heat 2.7 lb of coal of 9350 Btu and containing about 0.47 lb of ash must be burned per cu ft of furnace volume.

The effective furnace volume of the Port Washington unit is 55,000 cu ft. The total heat release at a steam output of 690,000 lb is 880 million Btu per hour, making the rate of heat release 16,000 Btu per cu ft of furnace volume per hour. For this rate of heat release 1.24 lb of coal containing 0.155 lb of ash must be burned per cu ft of furnace volume per hour. This amount of ash is only about one third of the amount in the Des Moines unit. That is, in the Des Moines unit the concentration of the ash per per cubic foot of furnace gases is about twice as high and the gases move through the furnace about one and a half times as fast as in the Port Washington unit.

There are four factors contributing to the slag deposition in the superheater of the Des Moines unit, the higher concentration of ash in gases, higher velocity of gases, lower fusion temperature of ash, and higher temperature of gases entering the boiler and superheater.

There is considerable difference in the design of the two units. The Port Washington unit as all the Milwaukee units has been designed by the Milwaukee engineers; it is a noncompetitive unit and costs more than the Des Moines unit which is highly competitive. Port Washington plant operates on reheat cycle. All of the reheating and about one half of the superheating is done in the furnace with surface absorbing heat mostly by radiation. With the radiant superheater and reheaters high concentration of heat in the furnace must be avoided, and that is one reason for a low-rate heat release. The steam is superheated to 830 F and reheated to the same temperature.

The Des Moines unit is designed for steam temperature of 925 F which is nearly 100 degrees higher than the steam temperature of the Port Washington unit. The superheater is entirely of the convection type and is located back of two rows of boiler tubes. The gases flowing over the superheater must not only contain enough heat to superheat the steam, but their temperature must be high enough to transfer the heat to the steam inside of the superheater. The necessary high temperature of gases entering the superheater requires high rate of heat release.

In the Des Moines unit the superheating is done after the gases leave the furnace, whereas in the Port Washington unit all of the reheating and about half of the superheating is done mostly by radiation before the gases leave the furnace. Hence the necessity of high rate of heat release in one case and low rate in the other.

It is the author's opinion that with the same rate of heat release, same coal, and similar design of units, there is no greater bombardment of the furnace wall by large ash particles and more accummulation of slag on the furnace walls with the tangential firing than there is in vertical firing. In the tangential firing the streams of fuel and air are directed toward the center of the furnace away from the walls. The streams are made to impinge on each other but not on the walls.

HENRY KREISINGER.[28]

[28] Engineer in charge Research and Development, Combustion Engineering Co., Inc., New York, N. Y. Mem. A.S.M.E.

Wood-Burning Space Heaters

TO THE EDITOR:

In the paper "Wood-Burning Space Heaters," by L. E. Seeley and F. W. Keator, published in the December, 1940, issue of MECHANICAL ENGINEERING, an account was given of the use of the power prover to show the presence of combustible gases not revealed by the Orsat. A calibration was made of the power prover versus the Orsat with charcoal in which it was found that the carbon monoxide (CO) as shown by the power prover was lower than that shown by the Orsat. While the object was to find the relation of the two readings with charcoal, the authors mistakenly assumed that if CO was the sole combustible gas, both instruments would give the same results. The fact is that the power prover, while responsive to all of the combustible gases present, uses on its indicating scale only the CO actually present in said gases. This has been found possible with the exhaust gases from gasoline engines due to the uniformity of the fuel and the fact that other combustible constituents appear to be present in predictable amounts, depending upon the

CO. Thus the actual heat of combustible gases is greater than the per cent CO reading of the machine indicates. It logically follows that if CO is the sole combustible gas, the reading on the power prover would be lower than the Orsat CO reading. The authors assumed that the power-prover indication was in terms of the equivalent CO regardless of the nature of the combustible gas. This explains why the power-prover readings were lower than the Orsat when charcoal was used. Fortunately, this error in the use of the scale in no way impairs the validity of the observations and conclusions of the authors. Fig. 9 showed that at times the CO readings of the power prover were higher and at other times lower than the Orsat due to the presence, at times, of combustible gases other than CO. It was found that during the distillation of the wood the power prover indications were relatively high and during the charcoal stage they were relatively low. For the purpose of this experiment the scale could have been anything at all since the deflection of the needle was necessarily responsive to the heat formed by the combustible constituents, whatever they were.

It was unfortunate that the basis of the scale was misunderstood since it may have created an erroneous impression regarding the accuracy of the power prover.

LAUREN E. SEELEY.[29]

Bust of Rankine

TO THE EDITOR:

I am very pleased to see in your December issue the fine notice given to the bust, erected at Virginia Polytechnic Institute, of John Macquorn Rankine.

The inception and completion of this idea is due entirely to the unselfish and continuous energy of Professor William H. Rasche of that Institute. We members of the class of '02 contributed money toward the cost of this project, but Professor Rasche contributed money, and time, and energy. The result is a great honor to him.

W. P. TAMS, JR.[30]

[29] Associate Professor, Yale School of Engineering, New Haven, Conn. Mem. A.S.M.E.

[30] Gulf Smokeless Coal Company, Tams, W. Va.

A.S.M.E. BOILER CODE

Interpretations

THE Boiler Code Committee meets monthly for the purpose of considering communications relative to the Boiler Code. Anyone desiring information on the application of the Code is requested to communicate with the Secretary of the Committee, 29 West 39th St., New York.

The procedure of the Committee in handling the cases is as follows: All inquiries must be in written form before they are accepted for consideration. Copies are sent by the Secretary of the Committee to all of the members of the Committee. The interpretation, in the form of a reply, is then prepared by the Committee and passed upon at a regular meeting of the Committee.

This interpretation is later submitted to the Council of The American Society of Mechanical Engineers for approval after which it is issued to the inquirer and also published in MECHANICAL ENGINEERING.

Following is a record of the interpretations of this Committee formulated at the meeting of January 10, 1941, which were subsequently approved by the Council of The American Society of Mechanical Engineers.

CASE No. 917

(Special Ruling)

Inquiry: In the construction of a fusion-welded drum with an intermediate circumferential seam, will the requirements of the Code be met if the longitudinal tube-hole ligament where the intermediate circumferential seam is placed is increased to take care of the weld, by a fraction of the longitudinal tube-hole ligament? The increased ligament is to have a longitudinal pitch equal to the regular tube-hole ligament plus $0.1Y$, Y being the width of the circumferential weld.

Reply: It is the opinion of the Committee that if the weld forming the circumferential joint is of the full thickness of the plate, and meets the requirements of Case No. 850 (that the hole does not come closer to the weld than $^1/_4$ in. from the edge of the fused metal), no deduction need be made in the minimum allowable working pressure computed for the same tube layout without a circumferential weld.

CASE No. 918

(Interpretation of Par. P-300)

Inquiry: Par. P-300 of the Code calls for partial data reports to be furnished for piping fabricated in accordance with this paragraph. Will it be considered as meeting the requirements of the Code if the piping manufacturers or fabricators who are in possession of the proper stamps, furnish the manufacturers' data report which includes the certificate of field assembly inspection?

Reply: It is the opinion of the Committee that in cases where the piping is furnished and erected by other than the boiler manufacturer, the contractor for the piping covered by this Code shall furnish a data report covering the shop and field-assembly inspections.

CASE No. 919

(Interpretation of Pars. U-59 and U-76)

Inquiry: As it is now generally conceded that the local stress relieving of nozzles and other welded attachments as provided for in Pars. U-59(*p*) and U-76(*e*) (4) is more likely to be injurious than beneficial, may not the requirements for local stress relieving of such attached parts be waived?

Reply: It is the opinion of the Committee, based on reported experience, that nozzles and other welded attachments on a Par. U-69 vessel need not be stress-relieved unless the vessel as a whole is required to be stress-relieved, provided all such nozzles and attachments are welded by a procedure which will prevent excessive locked-up stresses and warpage.

Caution: A certain degree of preheating provided either by the welding itself or by other means will be necessary in some cases.

If a vessel as a whole is not required to be stress-relieved but some parts, because of thickness if any welding is done on them, are required to be stress-relieved, the parts shall be so treated before being attached to the vessel.

Revisions and Addenda to Boiler Construction Code

IT IS the policy of the Boiler Code Committee to receive and consider as promptly as possibly any desired revision of the rules and its codes. Any suggestions for revisions or modifications that are approved by the Committee will be recommended for addenda to the code, to be included later in the proper place in the code.

The following proposed revisions have been approved for publication as proposed addenda to the code. They are

Table U-3. Revise to read as follows:

TABLE U-3 MAXIMUM ALLOWABLE WORKING STRESSES FOR NONFERROUS MATERIALS IN LB PER SQ IN. FOR METAL TEMPERATURES NOT EXCEEDING DEG F

Material	Spec. number	Subzero to 150	250	350	400	450	500	550	600	650	700	750
Muntz metal	S-24, S-47, B57-27	10000	9000	2000	1500	...	...	...	...	...	...	...
Red brass	S-24	7000	6500	5000	3000	1000	800	...	...	...	...	...
High brass	S-24	7000	6500	5000	3000	1000	800	...	...	...	...	...
Admiralty	S-24, S-47	9000	8500	6000	3000	1000	800	...	...	...	...	...
Naval brass	(6)	11000	10000	6000	3000	...	...	...	...	...	...	...
Copper-silicon alloy, types A and C (4)	S-36, S-37 (1)	10000	10000	5000	...	...	...	...	...	...	...	...
Steam bronze	S-41 (5)	7000	7000	6000	5500	5000	4000	3000	...	...	...	...
Steam bronze	S-46 (5)	6000	5500	4500	3500	...	...	...	...	...	...	...
Monel metal (2)	S-54	14000	14000	14000	14000	14000	14000	14000	14000	14000	14000	14000
Cupro nickel 70-30	S-47 (3)	11000	11000	11000	11000	11000	10000	10000	9000	9000	8000	8000
Cupro nickel 80-20	S-47 (3)	10000	10000	10000	10000	10000	9000	9000	8000	8000	7000	7000
Copper annealed, all types	S-20, S-22, S-23	6000	5000	4000	3000	...	...	...	...	...	...	...
Aluminum manganese alloy, annealed	S-39	2800	2400	1800	1600	...	...	...	...	...	...	...
Aluminum-manganese alloy quarter-hard or as-rolled	S-39	3500	3000	2400	2200	...	...	...	...	...	...	...

Notes: The stresses given in the above table may be interpolated to determine values for intermediate temperatures.

(1) Type A and C only.
(2) Applies to 70,000 lb tensile strength rolled and annealed material.
(3) 70-30 copper nickel and 80-20 copper nickel, types A and B only.
(4) There is doubt concerning the suitability of this material when exposed to certain products and/or high temperatures, particularly steam above 212 F and the user should satisfy himself that it is satisfactory for the service for which it is to be used.
(5) In the absence of evidence that the casting is of high quality throughout, values not in excess of 80 per cent of those given in the table shall be used.
(6) U. S. Navy Department Specification 46-B-6-i.

published below with the corresponding paragraph numbers to identify their locations in the various sections of the code, and are submitted for criticism and approval from anyone interested therein. It is to be noted that a proposed revision of the code should not be considered final until formally adopted by the Council of the Society and issued as pink-colored addenda sheets. Added words are printed in SMALL CAPITALS; words to be deleted are enclosed in brackets [ ]. Communications should be addressed to Secretary of the Boiler Code Committee, 29 West 39th St., New York, N. Y., in order that they may be presented to the Committee for consideration.

Par. P-274. Add the following footnote under the table:

Note: When a boiler is fired only by a gas having a heat value not in excess of 200 Btu per cu ft, the minimum safety valve relieving capacity may be based on the values given for hand-fired boilers above.

Tables P-9 and U-3 Add the following stresses:

Specification S-58. This specification will be identical with A.S.T.M. Specifications B57-27.

Specification S-59. This specification will be identical with A.S.T.M. Specifications A135-34.

Par. U-73(*a*). Revise first section to read:

Longitudinal joints on vessels covered by Pars. U-68 and U-69 shall be of the double-welded butt type and a reinforcement of at least $^1/_{16}$ in. shall be built up on each face of the weld, except that for plates $^1/_4$ in. or less in thickness the reinforcements need not exceed 25 per cent of the plate thickness.

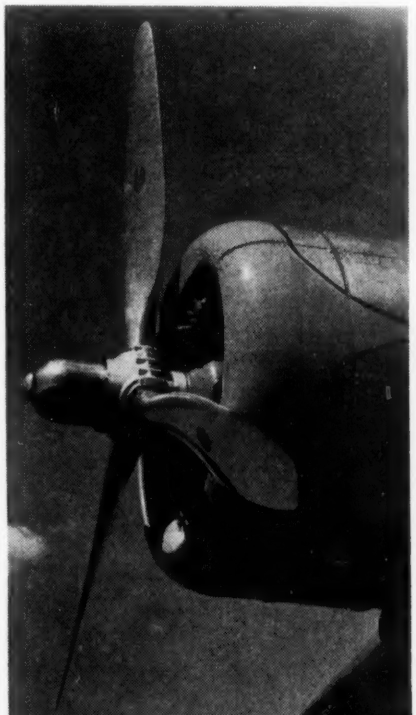
The reinforcement on either or both faces of the weld may be removed, but if not removed there shall be no valley, groove, or other change in contour along the edge or upon the surface of the weld that, in the opinion of the inspector, would be objectionable.

When a butt-welded joint is made the equivalent of a double-welded joint (See note in Par. U-67) by using backing strip and adding filler metal on one side only, the requirement for reinforcement applies only to the side opposite the backing strip. The backing strip may be allowed to remain or it may be removed.

	900 F	950 F	1000 F
S-35, S-33, S-57, grades F4, C4, and WC4..............	10200	8000	5000

Delete footnote (13)

Specification number	Grade	Notes and limitations	—20 to 650	700	750	800	850	900	950	1000	1050	1100
			For metal temperatures not exceeding deg F									
A.S.T.M. A193-39T*	B11	(11) (12)	16000	16000	16000	16000	13800	11000	8250	5850	3850	2200



"BLADES"

(Photograph taken by W. P. Brandegee and shown at the Fifth Annual Photographic Exhibit which was held during the A.S.M.E. Annual Meeting, Dec. 2–6, 1940, New York, N. Y.)

A.S.M.E. NEWS

And Notes on Other Engineering Activities

Industries of the Southeast Represented on Program for A.S.M.E. Spring Meeting, Atlanta, Ga., March 31–April 3, 1941

THE rapidly developing industrial empire of the Southeast, so conveniently accessible from Atlanta, Ga., affords abundant opportunity for excursions and technical inspection trips as well as subject matter for engineering discussion upon which the 1941 Spring Meeting of The American Society of Mechanical Engineers, to be held March 31 to April 3, with headquarters at the Biltmore Hotel, Atlanta, has been based.

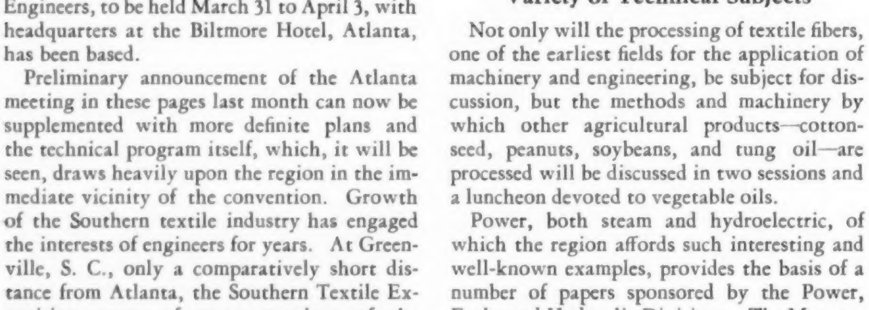
Preliminary announcement of the Atlanta meeting in these pages last month can now be supplemented with more definite plans and the technical program itself, which, it will be seen, draws heavily upon the region in the immediate vicinity of the convention. Growth of the Southern textile industry has engaged the interests of engineers for years. At Greenville, S. C., only a comparatively short distance from Atlanta, the Southern Textile Exposition, scene of many meetings of the A.S.M.E. Textile Division, will be in full swing during the A.S.M.E. meeting at Atlanta, and will be the scene of all-day textile sessions on April 4, thus affording a double incentive for engineers and textile men in particular to put the A.S.M.E. Spring meeting on their calendars.

Variety of Technical Subjects

Not only will the processing of textile fibers, one of the earliest fields for the application of machinery and engineering, be subject for discussion, but the methods and machinery by which other agricultural products—cottonseed, peanuts, soybeans, and tung oil—are processed will be discussed in two sessions and a luncheon devoted to vegetable oils.

Power, both steam and hydroelectric, of which the region affords such interesting and well-known examples, provides the basis of a number of papers sponsored by the Power, Fuels, and Hydraulic Divisions. The Management Division is cooperating with the Committee on Education and Training for the Industries in sessions devoted to timely subjects including apprentice training.

The Heat Transfer Group has provided a session at which subjects related to solar heating are to be discussed, and the Materials Handling Division is sponsoring a paper on the economics of strip mining with portable belt conveyers, with particular reference to clay working.



Atlanta Convention Bureau

REPRODUCTION OF SECTION OF THE CYCLORAMA, REALISTIC PAINTING OF THE HISTORIC BATTLE OF ATLANTA

(Housed in a museum of modern design in Grant Park, this huge battle painting is one of the few specimens of its kind remaining in the United States, and annually attracts thousands.)

Plan of Meeting Provides Opportunity for Relaxation

The general scheme of the 1941 A.S.M.E. Spring Meeting provides for technical sessions on Monday evening, and on the mornings of the next three days. Monday morning is devoted to registration and plant-inspection trips for students who will be in attendance not only from the Georgia School of Technology but also from other engineering schools in the Southeast where the Society maintains student branches. The student members are staging a technical session for Monday afternoon at Georgia Tech to which all A.S.M.E. members and guests are invited.

On Tuesday, Wednesday, and Thursday luncheons have been arranged. The students will be present at the Tuesday luncheon, while the luncheon on Thursday will stress vegetable oils and be addressed by A. Weisselberg, of New York, research secretary of the A.S.M.E. Process Industries Division. His subject will be "Research in the Process Industries."

Plant-inspection trips are scheduled for Tuesday afternoon, while Wednesday afternoon affords a break in the strenuous technical activities and is devoted to golf and sight seeing.

An informal get-together has been arranged for Tuesday evening, to be followed by a Student-Group dance. Wednesday evening will be the occasion for a banquet and dance, the high light of the social functions of the meeting.

To Visit LeTourneau Co. of Ga.

One of the most popular trips being arranged during the Spring Meeting is that to the plant of LeTourneau Co. of Georgia, at Toccoa, Ga., about 95 miles north of Atlanta. In making the arrangements for this trip the committee in Atlanta were fortunate in seeing Mr. LeTourneau, himself, for a few minutes. Mr. LeTourneau has an enviable reputation not

only in Georgia but throughout the United States as a most unusual person who exhibits an extraordinary originality in the design of earth-moving and other machinery.

The committee actually saw under construction a "digger" which will be able to scoop up a 31-cubic-yard mouthful of earth and remove it at high rate of speed to some other location. It is one of those things that ought to be included in a Ripley "believe it or not" program, but actually Mr. LeTourneau is able to make such machines work.

The Technical Program

The three technical sessions scheduled for Monday evening are devoted to Power, Education and Training, and Materials. W. LeR. Emmet, "Father of the Mercury-Vapor Process," will address the Power Session on applications of the process to existing power stations. His paper will be followed by one on the 1400-lb boiler experiment at Deepwater. The Education and Training Session will feature two educational films. At a third session, sponsored by the Materials Handling Division, the paper on strip mining with portable belt conveyers will be presented.

Tuesday morning's three sessions are to be devoted to Power, Education and Training, and Steam Separation. The first Fuels Session, on Wednesday morning, will afford opportunity for a discussion of steam-plant planning for the TVA, and the conversion of a wet-bottom furnace from intermittent to continuous slag tapping. On the same morning the Hydraulic Division will conduct the first of its sessions with a paper on Francis-turbine installations at Norris and Hiwassee dams.

The third Tuesday morning session will be jointly sponsored by the Management Division and the Committee on Education and Training for the Industries, and will deal with apprentice training and industrial marketing from the salesman's point of view.

Tuesday morning will also be the occasion of a fourth session, the first of those devoted to vegetable oils, with papers on mechanical processes in the production of vegetable oils, with particular reference to peanut oil, and the efficiency of cottonseed-oil recovery.

Thursday morning also provides four technical sessions. At the second Fuels Session there will be two papers, one related to the combustion of four fuels into one boiler, and the other to the utilization of refuse fuels at the 12th Street Station.

The Heat Transfer Session on Thursday morning will feature a paper on the performance of flat-plate solar-heat collectors and on radiation problems associated with absorption and radiation of gases with special reference to nocturnal irradiation predictions from aerological soundings.

At the second session on vegetable oils on Thursday morning the two papers will deal with the extraction of soybean and tung oils.

The final session on Thursday morning will be devoted to a paper on power-operated rakes for hydraulic intakes.


Atlanta Convention Bureau

PLANTS OF THE ATLANTIC STEEL COMPANY, GEORGIA'S ONLY STEEL MILL

Registration Fee for Nonmembers at the 1941 Spring Meeting

There will be a registration fee of $2 for nonmembers attending the 1941 A.S.M.E. Spring Meeting at Atlanta, Ga., March 31–April 3, 1941. For nonmembers wishing to attend just one session of the meeting the fee will be $1. This is in accordance with the ruling of the Standing Committee on Meetings and Program.

Members wishing to bring nonmember guests may avoid this fee by writing to the Secretary of the Society before March 24, 1941, asking for a guest-attendance card for the Spring Meeting. The card, upon presentation by a guest, will be accepted in lieu of the registration fee. Guests are limited to *two per member*.

A.S.M.E. Spring Meeting Program

Atlanta, Ga., March 31–April 3

Headquarters, Hotel Biltmore

MONDAY, MARCH 31

9:30 a.m. Council Meeting

Plant-Inspection Trips for Students

2:00 p.m.

Technical Sessions for Students at Georgia School of Technology

8:00 p.m.

Power (I)

Application of Emmet Mercury-Vapor Process to Existing Power Stations, by W. LeR. Emmet

Deep Water—1400-Lb Boiler Experiment, by D. C. Carmichael

Education and Training (I)

Movies of Machine-Tool Operations and Punch-Press Operations at General Electric Company With High-Speed Camera, with talks by W. L. Merrill and L. T. Weller

Erpi Classroom Film, by V. C. Arnspiger

Textile

Cooperation of Textile Industry With Defense Program, by Stephen Hale

Personnel Training for Textile Industry, by Allen Jones

TUESDAY, APRIL 1

8:00 a.m.

Meeting of Honorary Chairmen of Student Branches

9:30 a.m.

Power (II)

Study of Damper Characteristics, by P. S. Dickey

New Steam Plants Under Construction in the Southern Division of the Commonwealth and Southern Corporation, by E. C. Gaston

Education and Training (II)

Plans for Training in the College Grade, by R. A. Seaton

Army-Matériel Inspection, by Brig-Gen. R. W. Case

Steam Separation

Separation of Liquid From Vapor Using Cyclones, by Arthur Pollak and Lincoln T. Work

12:30 p.m.

General Luncheon—Students invited

2:00 p.m.

Plant-Inspection Trips

Management

The Relation of Apprentice-Training Programs to National Defense, by S. D. Moxley

Training Factory Workers at Wright Aeronautical Corporation, by Bartley Whiteside

6:30 p.m.

Informal Get-Together

8:30 p.m.

Student Group Dance

(Program continued on following page)

WEDNESDAY, APRIL 2

9:30 a.m.

Fuels (I)

Steam-Plant Planning for the Tennessee Valley Authority, by W. R. Chambers

Experiences With Wet-Bottom Furnaces, by A. L. Luke

Vegetable Oils (I)

Mechanical Processes in Vegetable-Oil Production, by Charles L. Lockett

Efficiency in Cottonseed-Oil Recovery, by John F. Leahy

Hydraulic (I)

Francis-Turbine Installations at Norris and Hiwassee, by G. R. Rich and J. F. Roberts

Materials Handling

Economics of Strip Mining With Portable Belt Conveyers (Clay Working), by William W. Kingman

12:30 p.m.

Planned Luncheon

Luncheon, Nominating Committee

2:00 p.m.

Individual Plant Trips

Golf Tournament

Sight Seeing

6:30 p.m.

Banquet and Dance

THURSDAY, APRIL 3

9:30 a.m.

Fuels (II)

Combustion of Four Fuels in One Boiler, by W. J. Lutz

Utilization of Refuse Coals at 12th Street Station, by J. A. Reich

Heat Transfer

The Performance of Flat-Plate Solar-Heat Collectors, by H. C. Hottel and B. B. Woertz

Radiation Problems Associated With Absorption and Radiation by Gases With Special Reference to Nocturnal Irradiation Predictions From Aerological Soundings, by James Anderson and L. M. K. Boelter

Vegetable Oils (II)

Continuous Solvent Extraction of Vegetable Oils With Special Reference to Soybeans, by C. W. Bilbe

Problems in Tung-Oil Extraction, by R. S. McKinney

Hydraulic (II)

Power-Operated Rakes for Hydraulic Intakes, by George T. Abernathy

12:30 p.m.

Vegetable-Oils Luncheon

Research in Process Industries, A. Weisselberg

1:00 p.m.

Entrain for Greenville, S. C.

Motorcade leaves for Greenville, S. C., with stop at Toccoa, Ga., to visit plant of LeTourneau Company

3:00 p.m.

Textile Session at Greenville, S. C.

(*Auspices of Textile Division and Greenville Section, A.S.M.E.*)

Textile Exposition at Greenville

6:30 p.m.

Engineers' Dinner at Greenville

A Letter to A.S.M.E. Wives

From the Wife of an Atlanta Member

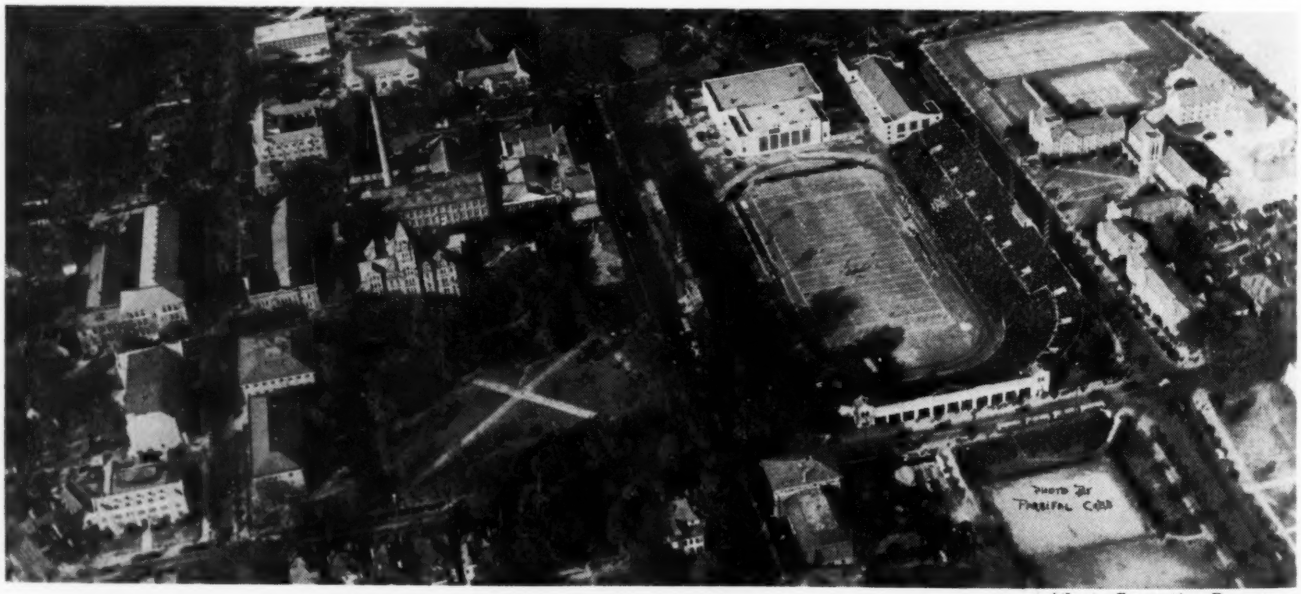
DEAR A.S.M.E. WIFE:

I hope this letter finds you with all plans made for a trip to Atlanta for the A.S.M.E. Convention from March 31 to April 3. We have all of us wives here been looking forward eagerly to meeting you and having you as our guests at that time. Please believe me when I say that it will be a real disappointment to us if a single one of you fails to come!

The Society couldn't have picked a better date for its meeting as far as we are concerned, for spring in Atlanta is truly beautiful, and we are going to be very proud when we drive you around our city to show you what we look like "in bloom." If you are a garden enthusiast you will be able to spot far more flowers than the violets, narcissus, crocus, daffodils, jonquils, pansies, and tulips, that I can promise you. Some of the flowering shrubs may be new to you among the Chinese magnolias, forsythia, pyrus japonica, spiraea, thrift, and star of Bethlehem. The peach, plum, cherry, and pear trees will be in full bloom, and the dogwood, if the weather continues as mild as it has been, will be bursting forth.

Since "Gone With the Wind" has made our city so well known to the greater share of the population of the country, we know you are going to be interested in seeing the city which has grown on the ashes of the old Atlanta. Driving down Peachtree Street you will not see Aunt Pittypat's home, but you will see a number that might have been. Even more numerous are the homes that might have been Scarlett and Rhett's postbellum mansion. A few of the places which the flames spared we know you will want to visit—the House of Three Flags, which was built in 1855 and was spared by both the Confederate and Federal troops because it flew, at different times, the Confederate, the United States, and British flags. General Johnston's headquarters in Atlanta likewise still stands. Mimosa and Bulloch Halls, both real antebellum homes are at Roswell, Georgia, which is only about 20 miles from Atlanta. Bulloch Hall was the family home of President Theodore Roosevelt's mother. The Cyclorama, out in Grant Park, is considered to be the country's greatest battle shrine and depicts in a very lifelike way, the battle of Atlanta. The figures in the foreground are sculptured ones, while the background is painted. Another place you will want to visit is the "Wren's Nest," the home of Joel Chandler Harris, creator of Uncle Remus and Br'er Rabbit stories.

If you are like I am, no trip to any city is



Atlanta Convention Bureau

AERIAL VIEW OF THE FAMOUS GEORGIA SCHOOL OF TECHNOLOGY IN ATLANTA, GA., JUST A FEW BLOCKS FROM THE BILTMORE, HEADQUARTERS OF A.S.M.E. 1941 SPRING MEETING

complete without a visit to the shops and stores. We think we are quite justly proud of ours, and we predict that a number of you are going to be doing a good bit of your spring shopping here.

In addition to these reasons why we would like to have you come to see us, we are, at this writing, in the process of arranging some parties and entertainment for your pleasure while you are here. Whatever it takes to make your trip a success we are going to try to supply.

If you have never made a trip to Atlanta, you may be wondering about the type of clothes to bring. Like any place else, Atlanta's spring weather is not completely predictable, but, barring very freakish weather, you will want suits, lightweight spring coats, and something cool, to wear in case of a very warm spell.

We are going to be at your service from the minute you arrive in Atlanta. You can see as much of, or as little of, us as is your wish. Until then, I remain

Sincerely yours,
An Atlanta Wife

A.S.M.E. Calendar

of Coming Meetings

March 12–13, 1941
National-Defense Meeting
Cleveland, Ohio

March 31–April 3, 1941
Spring Meeting
Atlanta, Ga.

April 3–4, 1941
Textile Division Meeting
Greenville, S. C.

April 22–23, 1941
National Management Conference on Defense
Philadelphia, Pa.

June 11–14, 1941
Oil and Gas Power Division
Kansas City, Mo.

June 16–20, 1941
Semi-Annual Meeting
Kansas City, Mo.

June 20–21, 1941
Applied Mechanics Division
University of Pennsylvania
Philadelphia, Pa.

October 12–15, 1941
Fall Meeting
Louisville, Ky.

Fall, 1941
Joint Meeting of A.S.M.E. Fuels and A.I.M.E. Coal Divisions
Lafayette College
Easton, Pa.

December 1–5, 1941
Annual Meeting
New York,
N. Y.

(*For coming meetings of other organizations see page 30 of the advertising section of this issue*)

M.I.T. to Offer Graduate Courses in Industrial Economics

RECOGNIZING the fact that after the war is over the nation will be confronted with problems of readjustment and reconstruction which in many respects will be more difficult than the problems created by war itself, the Massachusetts Institute of Technology next fall will start a graduate program of research and instruction on economic and labor problems of industry, according to an announcement by Professor Ralph E. Freeman, head of the department of economics and social sciences, under whose direction the reviews of books on economics published monthly in MECHANICAL ENGINEERING are prepared.

Long-Range Planning for Peacetime

Outlining the type of problems on which graduate students may work in different industries under the supervision of members of the faculty, Professor Freeman emphasized the need for long-range planning for peacetime conversion of plants and use of excess capacity in various industries now engaged in producing war products. He also spoke of the eventual absorption into industry of men in the army and how workers in defense industries can be redistributed. There is need for study, he said, of maintaining the impetus that the defense program is giving to technological invention and improvement to create a higher standard of living in the postwar period. He added, that in studying methods of assisting industry to make the eventual transition to peacetime operation and normal production, historical material should be taken into consideration to study the mistakes of the past.

While the new program in industrial economics at the Institute does not propose to study these problems to the exclusion of the more immediate defense-program projects, Professor Freeman emphasized the need for constructive thinking on future readjustments. Meantime, he said that several members of the staff of his department are already engaged in governmental work on current problems.

Professor Freeman explained that the new course will stress the combination of engineering techniques with those of the social sciences and students will have the benefit of the engineering resources of the Institute and opportunities for study in a wide range of industries.

Authorities on Staff

In recent years the Institute has brought to its staff a number of authorities in the various fields to be covered and this group will have the cooperation of the teaching staff in the scientific and engineering departments who will assist in seminars in industrial technology. Students will also have the benefit of close association with the work of the department of business and engineering administration in related studies of business management, and of the advanced work that has been done in the field of industrial statistics. The fundamental work of the industrial-relations section of the department of economics and social science is expected to be of special value in the course.

This new branch of professional training is expected to fit graduate students for careers as teachers, research specialists, and industrial consultants in a broad field of industrial activity in which they will bring together the technical information of industry possessed by the engineer and industrialist and the knowledge, both in its theoretical and practical aspects, of the economist. The new course is expected to enlarge the sphere of economists who are already sought by industrial enterprises, banks, trade associations, and labor organizations. There is also a growing demand for adequately trained men in the various administrative agencies of the government concerned with industrial relations.

In announcing the course, which requires a preparation including a bachelor of science or a bachelor of arts degree in a university of recognized standing, Professor Freeman said that fellowships will be available to specially qualified students in the new course. The program leads to the degree of doctor of philosophy in industrial economics.

SITUATED IN A FOUR-ACRE PARK IS THE ATLANTA BILTMORE HOTEL, HEADQUARTERS OF A.S.M.E. 1941 SPRING MEETING

Management Division's Defense Conference to Stress Labor's View

"LABOR'S Viewpoint Under National Defense," will be presented by a prominent labor leader at the National Defense Conference to be held at the Engineers' Club, Philadelphia, Pa., April 22 and 23, 1941, by the A.S.M.E. Management Division. Representatives of management and government will also take part in the session.

"This exchange of viewpoint on labor's relationship to the national-defense program should help every executive and supervisor in meeting the conditions in his own plant," stated Harold B. Bergen, partner, McKinsey & Company, who is planning the session. "Too often," said Mr. Bergen, "management does not exchange ideas with labor until problems have become chronic and then strained feelings make free expression of viewpoints difficult."

Other sessions of the Conference will deal with selection in training, multiple-shift problems, quality control, and subcontracts.

Prominent Military, Naval, and Industrial Leaders on A.S.M.E. Army-Navy Meeting Program

Announced for Cleveland, March 12 and 13

HEADLINERS in national defense representing industry and naval and military forces are scheduled to appear on the program of the A.S.M.E. Army and Navy Meeting, to be held March 12 and 13, 1941, at Cleveland, Ohio, with headquarters at the Hotel Statler, personifying the Society's slogan "Engineers Against Time" with which it seeks to emphasize the importance of this relationship.

As announced in these columns last month, the general objective of the Society's national-defense meetings, of which the one to be held at Cleveland is the third within the period of seven months, is to assist engineers and industrialists to convert peacetime plants for war work. The objectives of the two meetings held last fall are thus being carried forward at Cleveland.

Many Groups Cooperate With A.S.M.E.

Under the general guidance of the A.S.M.E. Committee on National Defense, the Society is bringing together in the Cleveland meeting the united efforts of its Aeronautic, Machine Shop Practice, Management, and Metals Engineering Divisions, its Committee on Education and Training for the Industries, and its Cleveland Section, and also cooperating with it as joint sponsor is the Army Ordnance Association.

General Wesson Commends A.S.M.E. Meeting

Success of the two previous meetings has again won for the Society the official "blessing" of Maj-Gen. Charles M. Wesson, Chief of Ordnance, U. S. Army, whose letter to William A. Hanley, President A.S.M.E., contains the following expressions of encouragement and approval.

Dear Mr. Hanley:

Best wishes for the success of the A.S.M.E. National Defense Meeting in Cleveland, March 12th and 13th.

We hope it will dramatize the need for using available skills and facilities to secure production now before new tools and plants can be made completely available. To this end, interchange of experience among manufacturers of ordnance and builders of machines is highly desirable.

Sincerely yours,
(*Signed*) C. M. WESSON
Major-General, Chief of Ordnance

General Marshall to Speak at Dinner

Other evidences of the high esteem in which the Society's efforts are held by the War Department are to be found in the fact that officers holding important positions have agreed to be present to address the meeting, to enter into the discussions, and to act as chairmen of some of the sessions. Heading the list of these distinguished officers is General George C. Marshall, Chief of Staff, United States Army, who is scheduled to speak at the informal dinner, on Wednesday night, March 12, at which William A. Hanley, President A.S.M.E., will preside and the Honorable Frank A. Scott, Cleveland, Ohio, will act as toastmaster. Representing the Army Ordnance Association on the dinner program will be C. F. Hood, president, American Steel and Wire Company, and president, Cleveland Post, Army Ordnance Association. For the Navy, Admiral Harold R. Stark, chief of Naval Operations, will speak.

Off-the-Record Informality to Vitalize Speeches

General Marshall will have no prepared address, which signifies that he will speak in a more intimate manner than would be possible were direct quotation for publication anticipated. In fact, the nature of the meetings on national defense already held by the Society—and the Cleveland meeting will follow the same pattern—calls for "off-the-record" oral discussions which afford speakers greater freedom of expression than could be allowed in manuscripts prepared for publication. Engineers in attendance at these previous meetings have sensed this more intimate quality in the addresses and discussions, so that the word has been spread around that the benefits of the meeting are for those in attendance. The reports that can be made for publication, because of the nature of the addresses and discussions, carry only a small portion of the actual proceedings, to profit from which attendance in person is imperative. None of the addresses will be broadcast.

Just as representatives of the military establishment are able to speak more freely in the informality of an unreported meeting, so also engineers and manufacturers find the conditions under which the sessions are conducted favorable for frank discussion of the subjects presented. This atmosphere not only adds to interest and develops the kind of comment that would be more restrained in the absence of it, but it also leads to straight-to-the-point discussion that is packed full of interest and value and saves time.

Luncheon Talk on Aircraft in Action

In addition to the dinner on Wednesday night there will be a luncheon on the same day at which Col. James L. Walsh, chairman, A.S.M.E. Committee on National Defense, will preside. The speaker at this luncheon is another of the War Department's headliners, Lt-Gen. Delos C. Emmons, commanding general, G.H.Q. Air Force. General Emmons' subject is "Fighting Aircraft in Action."

Program Based on Five Major Topics

The general plan of the Cleveland Meeting is built up around five major subjects: Ammunition manufacture, aviation manufacture, tank manufacture, subcontracting, gaging practices, and training and recruitment for national-defense industries.

Col. Winthrop Withington, chief, Cleveland Ordnance District, will open the meeting at 9:30 Wednesday morning. Two parallel sessions will be held, one on speeding tank manufacture, at which Lt-Col. John K. Christmas, Aberdeen Proving Ground, will preside, and one on subcontrating, with Col. James B. Dillard presiding.

Metal Cutting Discussed by Experts

The ammunition and aviation manufacturing sessions will be held after luncheon Wednesday in two more parallel conferences.

Maj. H. M. Reedall, executive officer, Cleveland Ordnance District, will preside at the ammunition session. Metal cutting will be the general subject of discussion at this session. Dr. Max Kronenberg, of the Cincinnati Milling Machine Company, will talk on coordination of speed, feed, depth of cut, horsepower, tools, and tool life for maximum shell production. Experts in metal cutting will discuss tungsten carbide and high-speed steel in shell turning among whom are J. R. Longwell, of the Carboloy Company, Philip McKenna, president, McKenna Metals Corporation, and M. F. Judkins, of the Firth-Stirling Steel Co.

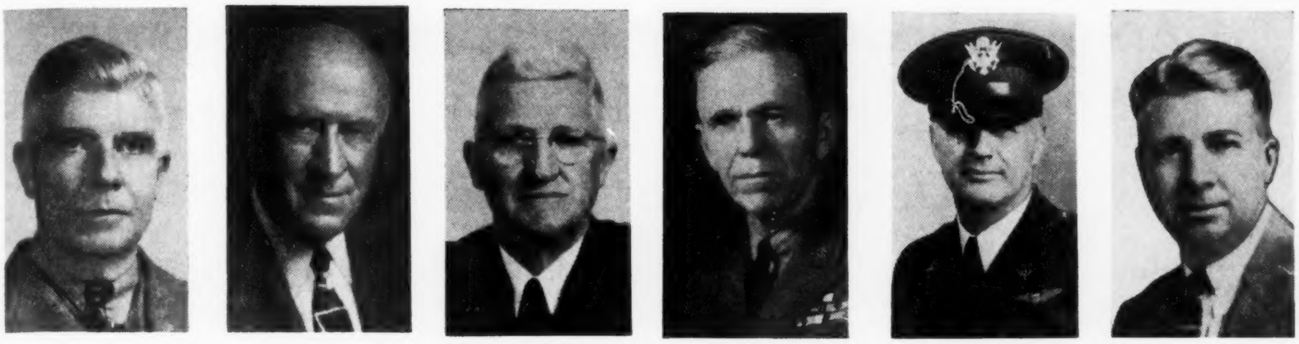
At the Wednesday afternoon aviation session the subjects for discussion will include a talk on planning for accelerated production, by Arvid Nelson, of the United Aircraft Corp.

The two parallel sessions scheduled for Thursday morning are devoted to gaging practices and to ammunition manufacture at which Lt-Col. A. B. Johnson, Ordnance Department, Office of the Assistant Secretary of War, will preside. Improvements in shell forging and improvised methods for rapid munitions manufacture are the principal subjects for discussion, which will include the important question of jobs for small plants.

At the gaging session S. B. Terry, chief engineer, Gage Division, Pratt and Whitney Aircraft Co., will speak on modern gaging practice, and Fay Aller, chief engineer, Gage and Machine-Tool Division, Sheffield Gage Corp., will discuss gaging operation in shell manufacture. Elmer J. Bryant, Gage Division, Army and Navy Munitions Board, Machine Tool Committee, will talk on gage supply. James H. Herron will preside.

Training of Workers and Inspectors

The concluding session of the meeting will be held on Thursday afternoon and will be devoted to training and recruitment of industrial personnel. A. R. Stevenson, Jr., chairman, A.S.M.E. Committee on Engineering and Training for the Industries, will preside. The training program of the State of Connecticut and the results obtained by it will be described by Dr. Alonzo Grace, Commissioner of Education, State of Connecticut. The Connecticut program was inaugurated two years ago.



Headliners at Cleveland

(From left to right: Col. Frank A. Scott, Col. Winthrop Withington, Chief, Cleveland Ordnance District, Admiral Harold R. Stark, Chief of Naval Operations, U. S. Navy, General George C. Marshall, Chief of Staff, U. S. Army, Lieutenant General Delos C. Emmons, Commanding General, G.H.Q. Air Force, Major H. M. Reedall, Executive Officer, Cleveland Ordnance District.)

Michael Kane, member of the staff of the National Defense Advisory Commission, will speak on "Organizing Intensive Job Instruction."

B. P. Shirey of the Frankford Arsenal will discuss the important subject of training district ordnance inspectors.

The Program in Detail

It is expected that the complete final program will be ready for distribution by mail shortly before the meeting. The program of the meeting, as complete as it is possible to announce it at the time of going to press, follows:

Program for Third Army and Navy Meeting on National Defense

Cleveland, Ohio, March 12–13, 1941

Hotel Statler, Cleveland, Ohio

Auspices of Army Ordnance Association, A.S.M.E. Committees on Education and Training and National Defense; A.S.M.E. Aeronautic, Machine-Shop Practice, Management, Metals-Engineering Divisions, and the A.S.M.E. Cleveland Section

WEDNESDAY, MARCH 12

9:30 a.m.

Opening Remarks by Col. Winthrop Withington, Chief, Cleveland Ordnance District

Speeding Tank Manufacture

Presiding: Lt-Col. John K. Christmas, Aberdeen Proving Ground

Building Combat Tanks for the U. S. Army, by Frederick A. Stevenson, Vice-President in Charge of Operations, American Car & Foundry Co.

Subcontracting

Presiding: Col. James B. Dillard

Subcontracting in Defense Production, by Robert L. Mehornay, Jr., Director, Defense Contract Service O.P.M., Washington, D. C.

12:30 p.m. Luncheon

Presiding: Col. James L. Walsh, Chairman, A.S.M.E. Committee on National Defense

Speaker:

Lt-Gen. Delos C. Emmons, Commanding General, G.H.Q. Air Force

Subject: Fighting Aircraft in Action

2:00 p.m.

Ammunition Manufacture

Presiding: Maj. H. M. Reedall, Executive Officer, Cleveland Ordnance District

Coordination of Speed, Feed, Depth, Horsepower, Tools, and Tool Life for Maximum Shell Production, by Max Kronenberg, Cincinnati Milling Machine Co.

Discussion on Tungsten-Carbide High-Speed Steel, by J. R. Longwell, Carboloy Co., Philip McKenna, President McKenna Metals Corp., and M. F. Judkins, Firth-Stirling Steel Co.

Aviation Manufacture

Presiding: Thos. A. Morgan, President, Sperry Products Corporation

Planning for Accelerated Production, by Arvid Nelson, Factory Manager, Hamilton Standard Propellers Division, United Aircraft Corp., Hartford, Conn. (Illustrated by slides and motion pictures)

6:30 p.m. Dinner (Business Dress)

Presiding: W. A. Hanley, President A.S.M.E.

Toastmaster: Hon. Frank A. Scott, Cleveland, Ohio

Speakers:

General George C. Marshall, Chief of Staff, United States Army

Admiral Harold R. Stark, Chief of Naval Operations, U. S. Navy

C. F. Hood, President, American Steel & Wire Company and President Cleveland Post Army Ordnance Association

THURSDAY, MARCH 13

9:30 a.m.

Ammunition Manufacture

Presiding: Lt-Col. A. B. Johnson, Office of the Assistant Secretary of War

Improvement in Shell Forging, by J. Waltman, Clearing Machine Co.

Discussion: A. T. Greiner, Salem Engineering Company

Improvised Methods for Rapid Munitions Manufacture, by George Trundle, President, Trundle Engineering Co.

Discussion: Jobs for Small Plants

Gaging Practices

9:30 a.m.

Presiding: Jas. H. Herron, Jas. H. Herron Co.

Gage Supply, by Elmer J. Bryant, Gage Division, Army and Navy Munitions Board, Machine Tool Committee, Washington, D. C.

Modern Gaging Practice, by S. B. Terry, Chief Engineer, Gage Division, Pratt & Whitney Aircraft Co., Hartford, Conn.

Gaging Operation in Shell Manufacture, by Fay Aller, Chief Engineer, Gage and Machine Tool Division, Sheffield Gage Corporation, Dayton, Ohio

12:30 p.m. Luncheon

2:00 p.m.

Training and Recruitment of Industrial Personnel

Presiding: A. R. Stevenson, Jr., Chairman, A.S.M.E. Committee on Education and Training for the Industries

Connecticut Training Program and Results, by Alonzo Grace, Commissioner of Education of Connecticut

Organizing Intensive Job Instruction, by Michael Kane, Member of Staff "Training Within Industry," The Advisory Commission to the Council of National Defense, Washington, D. C.

Training District Ordnance Inspectors, by B. P. Shirey, Training Officer, Frankford Arsenal

A.S.M.E. Endorses Statement of Professional Responsibilities and Work in National-Defense Housing Projects

AT ITS meeting in Philadelphia on January 7, the Executive Committee of the Council of The American Society of Mechanical Engineers endorsed a statement of professional responsibilities and work in national-defense housing projects referred to it by its Committee on Consulting Practice, S. Logan Kerr, chairman, prepared by representatives of The American Institute of Architects, the American Society of Civil Engineers, the American Society of Landscape Architects, and The American Society of Mechanical Engineers, and signed by M. X. Wilberding, member of the A.S.M.E. committee, who acted as the Society's representative in the conference at which the following statement was prepared:

Division of Responsibilities and Work Among the Planning Professions of Architecture, Civil Engineering, Landscape Architecture, and Mechanical Engineering on National-Defense Housing Projects

Every housing project built under the national-defense program should be functionally, if not physically, related to its neighboring communities and should promote the ultimate welfare of those communities. It should be properly integrated with them as to site and permanence of structure and as to transportation, educational, recreational, sanitary, and other facilities. The study of this integration is the normal function of the city planner.

Each project should provide adequate and appropriate shelters for those who are to occupy its dwellings and adequate and appropriate spaces and facilities to insure their normal health and well-being. The planning of such sites, facilities, and shelters and the supervision of their construction have long been the responsibilities of architects, engineers, and landscape architects in private practice, each performing his respective services on the project.

It is the opinion of the planning professions represented by The American Institute of Architects, the American Society of Civil Engineers, the American Society of Landscape Architects, and The American Society of Mechanical Engineers that their combined services are essential particularly in respect to defense housing and that by the employment of their professions in collaboration, the greatest advantage will accrue to the government.

This statement sets forth, to the extent practicable, the respective responsibilities of these four professions on any collaborative undertaking on national-defense housing projects.

It is not the intention to preclude any collaborator from performing any of the services of the other collaborators if he is qualified or competent to do so and if he normally performs such services by means of qualified and competent employees. Nor is it the intention that the divisions of responsibility and work as set out shall be inflexible; they should be used as guides for determining the proper divisions of work for a particular project, because the work to be done by each collaborator may differ in detail in the various projects.

The collaborative services may be performed under a single contract, a joint contract, or under separate contracts with each of the collaborators. All such contracts shall recite and include this full statement of "Division of Responsibilities and Work." The coordinating authority and the extent of his authority shall be stated in the contract of employment. In housing projects, the architect normally should be the coordinating authority.

Joint Responsibility of the Collaborators

The site having been determined, it shall be the joint responsibility of the collaborators to prepare and present to the employing governmental agency a report containing their preliminary estimates of costs and recommendations for the project, for its approval and acceptance.

The collaborative work and responsibility should cover the following fundamental features with respect to the site and the development of the project:

(*a*) Determination of traffic circulation; arrangement, width, and controlling grades of streets and alleys; railway trackage location.

(*b*) Determination of amount of land coverage, general locations of buildings, and general use of open areas.

(*c*) Determination of controlling grades on the open areas and the general elevation of proposed first and basement floors of buildings.

(*d*) Determination of general character of proposed landscape developments.

(*e*) Determination of general locations and types of utility and building services, street signs, fire hydrants, and project lighting (poles, light standards, and conduits).

(*f*) Determination of general character and list of drawings and specifications, to eliminate duplication and to produce efficiency and economy of design and construction.

Individual Responsibilities and Duties of Each Collaborator

1 *The Architect*

(*a*) Shall design, prepare drawings and specifications, and supervise construction of all housing units and buildings to be used for community purposes.

(*b*) Shall plan the architectural treatment of all other structures or parts thereof, except those specifically excluded by mutual agreement in advance among the collaborators.

(*c*) Shall direct the services of mechanical engineers engaged on the mechanical work in buildings.

(*d*) Shall direct the services of civil engineers where such services are required on structural and foundation problems of buildings and walls incident thereto.

2 *The Civil Engineer*

(*a*) Shall make surveys for, and prepare all property, topographic, and public-utility maps.

(*b*) Shall prepare plans for general grading and excavations for engineering developments unless otherwise mutually agreed upon among the collaborators.

(*c*) Shall design, prepare drawings and specifications for, and supervise the construction of domestic-water-supply systems, sewerage systems, storm drainage systems, yard-lighting facilities, heating mains, gas mains, and electrical-transmission lines outside of the buildings.

(*d*) Shall design, prepare drawings and specifications for, and supervise the construction of public streets and alleys and such private drives as are included by mutual agreement among the collaborators, including paving, sidewalks, curbs, culverts, retaining walls, and bridges incident thereto.

(*e*) Shall design, prepare drawings and specifications for, and supervise construction of such foundations and structural parts of buildings and other structures as are by reason of unusual conditions, not customarily designed by the architect.

(*f*) Shall set lines and grades for control of all work of the project other than for buildings.

3 *The Landscape Architect*

(*a*) Shall determine specific use and arrangement of land areas within the project based upon the general plan adopted for the project.

(*b*) Shall design, prepare drawings and specifications for, and supervise construction of lawns, interior walks and terraces, service areas, parking areas, fences, lawn irrigation and drainage, planting, pools, such other site surface improvements, and such private drives as are included by mutual agreement among the collaborators.

(*c*) Shall prepare grading plans and specifications for, and supervise construction on all

areas under landscape development unless otherwise mutually agreed upon among the collaborators.

(*d*) Shall design, prepare drawings and specifications for, and supervise construction of outdoor recreation areas, facilities and structures incident thereto, and all walls incident to the landscape development.

4 *The Mechanical Engineer*

(*a*) Shall design, prepare drawings and specifications for, and supervise the construction of central heating and steam-power plants, service utilities in the buildings, such as mechanical, electrical, heating, ventilating, air conditioning, refrigerating, plumbing, gas, and other services, and all facilities and equipment therefor.

The foregoing statement has been prepared by representatives of four planning professions, and we submit it for the approval of the governing bodies of the organizations represented.

The American Institute of Architects: Edwin Bergstrom, chairman, Chas. T. Ingham, Edmund R. Purves, Roy F. Larson.

American Society of Civil Engineers: Walter Jessup, Gustav J. Requardt.

American Society of Landscape Architects: A. D. Taylor, Markley Stevenson, William A. Strong, Joseph C. Gardner.

The American Society of Mechanical Engineers: M. X. Wilberding.

A.S.A. Announces Special Procedure to Develop Emergency Standards

THE American Standards Association announced Jan. 22, 1941, adoption of a special method for quick action in developing Emergency Standards needed for defense purposes. This method will make it possible to turn out standards for parts and materials used in defense production as rapidly as is consistent with a good technical job.

In the words of the committee drawing up this streamlined procedure, "It is highly desirable that the American Standards Association be prepared to act promptly on requests for the preparation of standards for use in the national-defense program. In order that such requests can be met with the speed that is essential, it is obviously necessary to greatly abbreviate the normal procedure of the Association."

The emergency procedure will empower special committees to act for the Association in starting new work, appointing technical committees, and in approving Emergency Standards.

The role that industrial standards play in peacetime production is greatly increased in time of national emergency like the present. This is because standards are a key factor in every program of large-scale production. Every government order is based upon specifications or standards; and as a single order frequently extends to hundreds of companies—manufacturers of parts and suppliers of materials—each company must control its operations closely so that the completed product will comply with the standards originally laid down in the order. Shortcomings in the original standards—obsolete requirements—unnecessarily close fits—faults in workmanship or materials—or difficulties in the way in which the standards are applied by the manufacturer, all result in bottlenecks which cut down the flow of aircraft, blankets, trucks, etc., from the factories.

Emergency Standards Format

All Emergency Standards will be published in a distinctive format that cannot be confused with regular American Standards. After the emergency has passed, the newly adopted procedure provides that "the Defense Emergency Standards will be reviewed by the appropriate committees, and approved, amended, or withdrawn, through the regular procedures of the Association."

The British Standards Institution and the Standards Association of Australia have for some time both been issuing Defense Emergency Standards developed under a similar relatively rapid procedure; and such standards have been exceedingly valuable to the governments and the industries of those countries in connection with their emergency war procurements. An interesting example of this work is the part the British Standards Institution has played in estimating tin-plate requirements. Each section of industry was asked to standardize its requirements for tin cans in order to effect economies in the use of steel and so release material essential for armament purposes. It is estimated that as a result of the standardization work a saving of between 40,000 and 50,000 tons of tin plate a year will be effected. In another case standardization of steel requirements will, it is estimated, save Britain 60,000 tons of steel a year. The British Standards Institution has carried through a number of special defense jobs for its government, among them specifications for air-raid shelters and methods of securing effective blackout at entrances to buildings.

Work Already Started

Among the defense jobs on which the American Standards Association is already working are: tool steels, screw threads, bolts and nuts and wrench-head openings, machine pins, wire and sheet-metal gages, mechanical fits, and statistical methods of quality control in mass production. Many of its safety-code projects are also important in providing protection for workmen on defense production jobs.

Conference for Mechanical-Engineering Teachers to Be Held at Purdue, June 29 to July 3

A CONFERENCE for teachers of mechanical engineering, sponsored jointly by Purdue University, the Society for the Promotion of Engineering Education, and The American Society of Mechanical Engineers, will be held at Purdue, June 29 to July 3. The committee in charge of the session consists of E. S. Ault, chairman, H. L. Solberg, secretary, and C. W. Beese. Chairmen of the program committees for special sessions are: J. I. Yellott, heat power; F. C. Stewart, mechanical laboratory; R. W. Morton, machine design; C. H. Casberg, manufacturing processes; C. A. Koepke, management and process supervision; K. D. Wood, aeronautics; and G. L. Tuve, engineering theses and research.

The tentative program is as follows:

Meetings of General Interest

Meetings of general interest (Sunday evening and four mornings)

Sunday dinner meeting: "Aims and Scope of the Mechanical-Engineering Curriculum"

Monday Morning: "Specialized Vs. General Curricula." A symposium followed by free discussion from the floor. How much time should be devoted to special application courses; how much free choice of subjects; how much of nontechnical courses; what are the fundamentals; where are we tending?

Tuesday Morning: "Experimental Laboratory Methods." A prepared symposium followed by free discussion from the floor. Subject matter of laboratory instruction (some other than heat power), effective methods of instruction, experiment vs. demonstration, correlation with other subjects, handling of large sections

A pertinent paper on some phase of preparedness as related to education

Wednesday Morning: "Aids to Teaching." A talk and demonstration of available methods and equipment

"Fluid Mechanics Vs. Hydraulics." A prepared round-table discussion followed by free discussion from the floor

Thursday Morning: "Selecting and Training a Teaching Staff." A talk by an experienced engineering administrator. Source of supply, inbreeding, promotion policy, training, how to eliminate on misfits

"Encouraging Selected Students to Graduate Study." A talk on aims, methods, and requirements for graduate study. Requirements for graduate degrees

Meetings of Limited Interest

Meetings of limited interest (three afternoons, simultaneous sessions)

Monday Afternoon: Sessions on heat power, machine design, aeronautics, and process supervision

Tuesday Afternoon: Sessions on engineering theses and research, machine design, and management

Wednesday Afternoon: Sessions on manufacturing processes, heat power, and mechanical laboratory

A.S.M.E. Council Adopts Report on Consulting Engineering Practice and Fees

THE problems facing the consulting mechanical engineer in setting fees for his services, in defining the scope of his activities, and in determining the cost to him of rendering service have been before The American Society of Mechanical Engineers for some time. Early in 1940, President McBryde initiated an investigation of these problems and in August he appointed a Committee on Consulting Practice to analyze them in the light of the greatly increased use of consulting mechanical engineering services in the national-defense program and also in relation to the broad aspects of rendering consulting services in the fields which are predominantly of a mechanical-engineering nature.

The Committee on Consulting Practice was asked to complete its work in time for the report to be considered by the Council at the A.S.M.E. Annual Meeting in December. To accomplish this work with as little delay as possible, a small committee was appointed to prepare the draft of the report. The committee consisted of S. Logan Kerr, chairman (United Engineers & Constructors, Inc., Philadelphia, Pa.); Paul L. Battey (partner, Battey & Childs, Chicago, Ill.); and M. X. Wilberding (president, Wilberding Company, Inc., Washington, D. C.). The initial meeting took place August 21 in Washington, at which time Messrs. Kerr and Wilberding of the committee and C. E. Davies, Secretary A.S.M.E., outlined the scope of the investigation and the items to be covered in the report.

Draft of Report Reviewed by Consultants and Users of Consulting Services

Subsequent meetings brought forth a preliminary draft which was reviewed carefully by the committee members and Mr. Davies and then sent to a number of representative engineers (in all parts of the country) fully conversant with consulting engineering problems as they relate both to rendering and to using such services. The finished draft was presented to the Executive Committee of the Council in November, together with the written comments of this large informal "board of review." The Executive Committee referred the report back to the Committee on Consulting Practice with the request that the comments of the reviewers be studied and incorporated in the report if it were feasible to do so.

A.S.M.E. Council Adopts Report Dec. 2, 1940

Only a few modifications were required to clarify the meaning of certain sections and the final report was sent to all members of Council well in advance of the scheduled meeting, Dec. 2, 1940. The report was presented by Mr. Kerr and, following discussion by members of the Council, it was adopted unanimously. While there are, of necessity, no mandatory provisions for enforcement of the recommended schedule of fees, the report as adopted by the Council does summarize the best practice followed by reliable consulting engineers and consulting engineering organizations in the United States. Definitions are also given of the various elements which enter into the cost of rendering consulting engineering service.

The Committee on Consulting Practice has been reappointed with the same personnel and is cooperating with similar groups in other societies, acting as representatives of the A.S.M.E. at joint conferences, and is studying the types and forms of contracts and accounting methods for consultants.

An abstract of the report has been prepared and is included with this article for the benefit of all A.S.M.E. members. *Where members or organizations contemplate using consulting mechanical-engineering services, it is recommended that a copy of the complete report be studied.*

Abstract of Report

The report has been divided into ten sections: (1) General principles for consulting work; (2) classification of consulting services; (3) designation of mechanical-engineering projects; (4) cost of rendering consulting service; (5) types of service on design projects; (6) recommended bases for making charges; (7) repetitive work; (8) drawings and designs; (9) patents; and (10) confidential data.

The report defines the various types of consulting service and classifies them into two broad groups:

(*A*) *Personal Service, Reports, Investigations, etc.*

1 Individual service
2 Appraisals, valuations, rate studies, reports
3 Management and production engineering services
4 Inspection or testing of apparatus, equipment, etc.

(*B*) *Design Projects*

1 Machinery or equipment consulting services
2 Consulting services on complete projects or sections of projects

Since the report deals primarily with mechanical-engineering projects, a detailed list was prepared covering: (1) Complete projects; and (2) mechanical-engineering sections of other types of projects. Table 1 lists these individual items.

TABLE 1

Group 1: Projects Predominantly Mechanical Engineering in Nature

Industrial plants
Process industries
Manufacturing plants
Mineral industries (except mines)
Steam power plants
Boiler plants
Internal-combustion power plants
Railway shops and terminals
Industrial water supplies
Industrial waste disposal
Pumping plants
Hydraulic-turbine installations (not including dams or reservoirs)

Group 2: Mechanical-Engineering Sections of Other Types of Projects

Mechanical equipment of buildings
Mechanical features of housing developments
Mechanical design of navigation locks, dry docks, and dredges
Mechanical features of mining operations
Industrial and mechanical features of shipyards
Mechanical services and facilities at airports, etc.

Determination of Fees

For each of the types of service the preferred basis of making charges has been recommended. These are shown in Table 2.

For per-diem rates covering personal service, reports, and similar activities a minimum rate of $50 per day for each day or fraction thereof, with a minimum charge of $100 for each engagement is recommended. Where special technical knowledge or skill is involved, charges from $100 to $250 per day are considered reasonable.

When long-term engagements are required, a reduction of 25 to 50 per cent from these minimum rates is justified providing the term of engagement is in excess of one week to ten days. Variations of the per-diem rate such as billing

TABLE 2 TYPES OF SERVICE AND PREFERRED BASIS OF MAKING CHARGES

(*A*) Personal Service, etc.	Per diem	Annual retainers	Lump-sum fees	Percentage of work	Cost-plus-a-fee
1 Personal service	X	X	X	..	..
2 Appraisals, valuations, and reports	X	..	X	..	X
3 Management and production engineering services	X	X	..	..	X
4 Inspection or testing of apparatus, equipment, etc.	X	..	..	..	X
(*B*) Design Projects					
1 Machinery or equipment consulting services	X	X	..	..	X
2 Consulting services on complete projects	..	..	..	X	X
3 Consulting services on sections of projects	..	..	..	X	X

TABLE 3 RECOMMENDED MINIMUM FEES BASED ON NET COST OF WORK DESIGNED BY CONSULTING ENGINEER

(Recommended minimum fees expressed as a percentage of cost of work)

Net cost of work, dollars	*A* Mechanical equipment of buildings With supervision, per cent	*B* Mechanical equipment of buildings Without supervision, per cent	*C* Complete mechanical-engineering projects, per cent
25,000 or under	10	$8^1/_2$	14
50,000	$8^3/_4$	$7^1/_2$	$12^3/_4$
100,000	$7^1/_4$	$6^1/_4$	$10^1/_2$
200,000	$6^1/_4$	$5^1/_4$	9
300,000	6	5	8
500,000	6	5	8

at three times pay roll or cost-plus-a-fee, and cost-plus-a-percentage are also recommended.

Percentage Fees

Where the scope of services can be determined in advance with some degree of accuracy and where the total cost of the work does not exceed $500,000 the method of evaluating fees as a percentage of the cost of the work has been recommended as shown in Table 3

The detailed description of the various items included under this service is set forth in the complete report. It should be noted that these percentage fees do not include reproduction or communication costs, living or traveling expenses incurred on account of the work, nor do they include resident inspection or supervision at the site. Such items are billed in addition to the percentage fee as are field surveys, etc.

Cost-Plus-A-Fee Contracts

For most of the services, particularly those dealing with design work, the *cost-plus-a-fee* basis of compensation has been recommended as being the most equitable arrangement for both the consultant and the client. This is particularly true where the indeterminate scope of preliminary engineering services, coordination with process studies, research and experimental work, and preparation of estimates are required in addition to the design.

For cost-plus-a-fee contracts it is recommended that the fees charged in addition to the direct costs and overhead be not less than 2 to $2^1/_2$ per cent for contracts over $500,000; the lower figure applying to the minimum cost figure and the 2 per cent to projects costing in excess of $10,000,000. Where smaller projects are involved with a cost of less than $500,000, a fee varying from $2^1/_2$ to $3^1/_2$ per cent is recommended. In all cases with this type of contract the fee should be based upon the estimated construction cost or upon the final cost, whichever is the lower.

Cost of Rendering Consulting Service

In establishing the cost of rendering any form of consulting services, it should be noted that the broad principles of doing business or of performing work are applicable to consulting engineering in the same degree as to manufacturing or other industries. The same general elements of cost, the basic principles of keeping accounts, the definition of direct cost, of overhead, of executive, sales, and other expenses are all present in consulting engineering work.

The segregation of costs based upon the same general classifications as for industrial work are as follows:

1 *Direct Costs for Services or Supplies Utilized on Contract*

(*a*) Salaries of engineers, assistants, draftsmen, and other employees while engaged on project

(*b*) Drafting and stenographic supplies and expenses

(*c*) Reproduction costs such as blueprinting, photostating, mimeographing, printing, etc.

(*d*) Communication expense, telephone, telegraph and postage

(*e*) Living and traveling expenses of employees and principals when away from home office on business connected with project

2 *Overhead Costs*

(*f*) Rental or other costs involved in providing office and working space for employees and principals

(*g*) Taxes and insurance

(*h*) Depreciation or rental of furniture, fixtures, drafting and engineering devices and instruments

(*i*) Library and periodical expenses

(*j*) Time of employees not in productive work including idle time of staff between engagements or when not actually required on the project. This constitutes a part of the cost of "readiness to serve"

3 *Executive and Administrative Expense*

(*k*) Executive salaries and administrative expense including accounting and similar charges necessary to carry on business

(*l*) Time of principals, partners, or corporation executives

(*m*) Sales and new business expense

It is often customary to group the overhead items in a single classification and bill them as a percentage of the direct costs. This percentage is usually set at 75 to 100 per cent of the direct pay-roll expense. No overhead is added to reproduction costs, communication expense, or living and traveling expense.

The executive and administrative expense is covered by the fee which should also provide a reasonable allowance for profit to the individual, the partnership, or the corporation.

Dual Activities of Executives and Principals

In many organizations, particularly those of small or medium size, principals, partners, or officials of corporations are called upon to perform executive or administrative duties concurrently with technical or advisory service to clients. Such a dual role would make it permissible to charge the client for the proportion of time devoted to technical or advisory work and to consider such time as part of direct cost of performance service. Great care must be taken to prevent any time spent in purely executive or administrative capacities from being considered as anything except overhead executive or administrative expense.

Repetitive Work

In cases involving housing developments, ammunition depots, storage or warehouse projects where a large number of individual structures are built from a single set of drawings it is recommended that a modification of the fees on a sliding scale be employed. This varies from 70 per cent of the normal fee for two identical units down to 35 per cent of the base fee for six or more identical units.

Drawings and Patents

The report also deals with the ownership of drawings and patents. It is recommended that confidential data relating to process work be carefully guarded by the consultant. In cases where a confidential design is carried out by the consultant it is recommended that the contract between the client and the consulting engineer include provision for their mutual protection which would outline the procedure to be followed by the consulting engineer before undertaking similar engagements for other organizations and also specifying a reasonable time limit within which such restrictions should apply.

A.S.M.E. Test Code for Gaseous Fuels

THE Test Code for Gaseous Fuels, the last of three test codes for fuels used in the generation of power, was recently completed by Power Test Codes Committee No. 3.

The Power Test Codes Committee will welcome criticism and comment from those who have special interest in and knowledge of this field. Printer's proof copies may be had on application to A.S.M.E. headquarters.

The personnel Committee No. 3 is as follows: W. J. Wohlenberg, chairman, E. G. Bailey, B. L. Boye, H. W. Brooks, S. B. Flagg, D. M. Myers, F. G. Philo, G. S. Pope, E. B. Ricketts, F. M. Rogers, E. X. Schmidt, Nicholas Stahl, and E. N. Trump.

The Test Code for Gaseous Fuels is intended primarily to specify standard methods for determination of those chemical and physical properties which serve as indicators of the value of gaseous fuels.

In the formulation of this code the committee has kept in mind (1) that usually these determinations of chemical and physical properties must be made at or adjacent to location where fuel is used, and where neither equipment nor personnel are available for, test such as a research laboratory might be prepared to make; and (2) that the code should include, primarily, methods for determination of (*a*) heat value, and (*b*) those properties involved in computing air required for, and resultant products of, combustion.

Among the Local Sections

Colonel Walsh Guest Speaker at Anthracite-Lehigh Valley

AT THE Jan. 24 meeting of the Anthracite-Lehigh Valley Section held in Bethlehem, Pa., the guest speakers were Colonel James L. Walsh, chairman of the A.S.M.E. Committee on National Defense, and S. Martin, Jr., General Electric Co. Colonel Walsh opened the meeting with an interesting discussion of national defense and the vital part played in it by mechanical engineers. Mr. Martin described the progress and new developments in the field of air conditioning. More than a score of members attended the meeting despite the inclement weather.

Baltimore Has Turnout of 85 at January Session

Meeting in the Engineers Club of Baltimore on Jan. 27, the Baltimore Section presented as guest speaker, Donald F. Lane, Bethlehem Steel Company, who talked on employee training at the Maryland plant of the Bethlehem Steel Co. He described the various phases of employee training in use at the present time and the relationship of progress in training courses to promotion. Although this was a regular Section meeting, it was arranged entirely by the Junior Group. There were 85 members and an uncounted number of guests present, including student members from The Johns Hopkins University.

Boston Section Is Honored by Presence of President Hanley

The January meeting of the Boston Section was held on the 23rd at M.I.T. After the usual dinner, Chairman G. K. Saurwein opened the meeting by calling upon Arthur L. Williston, first chairman of the Section, to present a Fifty-Year Badge of the A.S.M.E. by proxy to Charles Davis, of Bass River on Cape Cod. Ralph Curtis, second secretary of the Section and himself a fifty-year member, accepted the badge in behalf of Mr. Davis. Mr. Saurwein then introduced Colonel James L. Walsh, chairman of the A.S.M.E. Committee on National Defense, who outlined the activities of the Society in the program and called the engineer the key man in the production of munitions of war and increased facilities for their production. The chairman of the Section then introduced the honored guest of the evening, William A. Hanley, President of the A.S.M.E., who spoke on "Why National Defense—An Engineer's Viewpoint." He stated that the maintenance of our civilization rested upon the solution by engineers of industrial problems immediately facing the country and the world. An interesting and lively discussion period followed the president's remarks.

Bridgeport Section Meeting Features Photoelasticity

Two hundred members and guests of Bridgeport Section met on Jan. 2 in the Public Library Auditorium to hear a paper on "Photoelasticity" given by Prof. William M. Murray, M.I.T. His discourse, amply illustrated with lantern slides, proved very interesting and educational to the audience, many of whom were prominent engineers.

Manual Versus Mechanical Aids at Central Indiana

The Jan. 17 meeting of Central Indiana Section was devoted to the topic of "Manual and Mechanical Manufacturing Operations," as presented by Fred L. Pyle and R. B. Holmes. After the showing of a motion picture depicting the manual and mechanical processes in the pattern shop, foundry and machine shop, Mr. Pyle discussed the film, and Mr. Holmes placed on view the drawings of a coal drier and explained its construction and operation.

Central Pennsylvania Discusses Tacoma Bridge Failure Before 330

One of the greatest crowds to ever attend a Central Pennsylvania Section meeting, 330 members and guests, was present on Jan. 20 at The Pennsylvania State College to hear a paper on the failure of the Tacoma Bridge to have been given by Prof. F. B. Farquarson, who was unable to appear. However, a motion picture was shown of the bridge and its failure while running comments were given by Professor Mavis. Professor Bernhard then demonstrated by means of simple models just how the failure occurred.

Cleveland Section Has Program on Hundred Horsepower Hands

"Hundred Horsepower Hands" was the title of the subject presented on Jan. 16 before the Cleveland Section by Maxwell C. Maxwell. His lecture before the 100 members and guests, illustrated with silent and sound movies, covered the history and development of materials-handling equipment, such as trucks, hoists, conveyers, etc.

Photoelasticity Session Held by Colorado Section

Dr. J. H. A. Brahtz, director of the photoelasticity laboratory, Bureau of Reclamation, was the guest speaker on Jan. 17 before the Colorado Section. He briefly reviewed the early history and developments of the various photoelastic methods. Arrangements of apparatus and results were illustrated by means of slides. Membrane analogy and the interferometer methods were also explained and illustrated. A lengthy discussion was enjoyed by all.

Annual Ladies' Night Held Jan. 7 by Detroit Section

D. Grant Mickel, Detroit traffic engineer, addressed the Jan. 7 Detroit Section annual ladies' night on "Detroit's Traffic Problem." Stressing the extreme financial losses due to traffic accidents, Mr. Mickel described the many studies being made and the program now in effect to increase traffic safety and movement facility. A model illustrated a new device for the selective operation of traffic lights intended to give preference to the highway with heavier vehicle density. L. J. Schrenk, superintendent of the Public Lighting Commission, discussed the fine results obtained in accident reduction through the use of improved highway lighting and better maintenance of traffic signals.

More Than 100 Present at the Jan. 16 Meeting of Los Angeles

The dinner meeting of the Los Angeles Section on Jan. 16 was attended by 100 members and guests. H. R. Eggleston, chairman of the Local Sections Committee of the Society, reported on the Annual Meeting of the A.S.M.E. held in New York. Prof. R. L. Daugherty, California Institute of Technology, and regional adviser for engineering and defense training, spoke on the need of more and better trained technical men in the national-defense program. The speaker of the evening, Prof. Thurston H. Ross, director of business research, University of Southern California, spoke on the engineer's place in management, criticizing the present trends in management in which the engineer does not have a voice commensurate with his responsibilities and duties in the general productive scheme.

PAST-PRESIDENT JAMES H. HERRON PRESENTS 50-YEAR SERVICE PIN TO A. H. BATES AT CLEVELAND SECTION MEETING, JAN. 16

Resinous Wood Products Discussed at Louisville

On Jan. 23, the Louisville Section held a meeting at the Speed Scientific School. Thirty-five members and guests were present. T. W. Rucker, Mengel Co., gave a talk on the production and uses of resinous wood products. Everyone enjoyed the paper and the way it was presented by the speaker.

Minnesota Section Learns of Romance of Numbers

The Minnesota Section held a dinner meeting on Jan. 27. Dr. Lorenz G. Straub, chairman of the Section, introduced Prof. H. C. T. Eggers, who gave an illustrated talk on "The Romance of Numbers." His talk covered the history of numbers, pointing out the high lights of the different numerical systems from prehistoric times to the present. Ancient peoples encountered many difficulties in the use of numbers until the basis of the modern decimal system was established by an unknown Hindu who discovered the use of zero some time in the third century A.D.

New Haven Holds Joint Meeting With S.A.M.

New Haven Section held a joint meeting with the Connecticut Chapter of the Society for the Advancement of Management on Jan. 16 at Yale University. Alonzo G. Grace, commissioner of the Connecticut Department of Education, led a panel discussion on "Youth, the Schools, and Industry." Members of the panel included educators, industrialists, and a recent graduate of an apprentice-training program.

New Engineering Materials Introduced at Philadelphia

At the Jan. 28 meeting of the Philadelphia Section, attended by 175 members and guests, C. F. Kidder covered synthetic materials with considerable emphasis on Lucite and Neoprene. Thomas D. Perry spoke on plywood and its many uses, particularly its application to aircraft.

Providence Section Has 75 Present on Movie Night

Seventy-five members and guests of Providence Section were present on Jan. 7 for the showing of the sound motion picture, "Sinews of Steel," which covered the making of wire rope from the iron ore to the finished product.

San Francisco Hears Talk on War by General Barrows

Maj-Gen. David P. Barrows, U. S. Army (retired), former president of the University of California, and professor of political science, was the guest speaker of the San Francisco Section and other groups of the S. F. Engineering Council at the joint meeting of Jan. 24. More than 200 engineers listened in rapt attention to General Barrows as he stated that the place of the engineer in war is in the design and construction of the armament and equipment for war, while the place of the officer in the army and navy is in a position which will help to maintain the morale of the troops. Based on personal experiences in Europe and Africa, he predicted that Great Britain would emerge victorious and the German people would eventually throw off the shackles of Nazism.

President Hanley Guest of Syracuse Section

President William A. Hanley of the A.S.M.E. was the guest and chief speaker at the dinner meeting of the Syracuse Section on Jan. 28. The first speaker was Carleton Brown, general manager of L. C. Smith and Corona Typewriter Co., who welcomed the guest of honor on behalf of the Syracuse Manufacturers' Association. Harte Cooke then outlined briefly the history of the A.S.M.E. Then Willis H. Carrier, father of the air-conditioning industry, introduced President Hanley who read an advance release concerning the plan to advance the graduation of the class of 1942 in engineering schools to February from June by means of a summer session in 1941. He then talked on "Why National Defense?"

Testing-Machine Session of Toledo Section Draws 220

The Jan. 9 meeting of Toledo Section attracted 40 members and 180 visitors. C. H. Gibbons, Baldwin-Southwark Co., discussed the history and development of testing equipment, principally the tension-compression type, and noted the trends in the various countries during the last century. Load-extension recording devices and strain-indicating instruments were also described. The evening was concluded with a motion picture on the manufacture of spark plugs.

Washington, D. C., Section Presents Free Lectures

Starting on Jan. 16, the Washington, D. C., Section of the A.S.M.E. is presenting a series of eight lectures on "The Engineering of Applied Mechanics." Members of the Society are admitted free while nonmembers pay an enrollment fee of one dollar. All the lectures are expected to dovetail together to yield a comprehensive picture of the whole field of dynamics. As stated in the announcement of the lectures, each speaker is an authority in his field and will present his particular subject so that the average engineer can understand it. Each speaker's primary objective will be to convey information to a group of mechanical engineers; not to exchange ideas with the few who are already expert in the same field. The program of lectures follows:

Jan. 16	"Modern Methods of Determining Dynamic Stresses in Structural Members," by A. V. de Forest, Massachusetts Institute of Technology
Jan. 30	"Critical Instability of Structures," by L. B. Tuckerman, U. S. Bureau of Standards
Feb. 6	"A General Outline of the Field of Dynamics With Broad Applications to Engineering," by Rupen Eksergian, Budd Manufacturing Co.
Feb. 20	"Specific Applications of Applied Mechanics to Problems in Aviation," by E. J. Ryder, Civil Aeronautics Authority
Mar. 6	"Applied Photoelasticity," by M. Hetényi, Westinghouse Research Laboratory
Mar. 20	"Early History of Some Mechanical Principles," by Paul R. Heyl, U. S. Bureau of Standards
Apr. 3	"Roller Bearings and Their Application to Military Equipment," by T. V. Buckwalter, Timken Roller Bearing Co.
Apr. 17	"Application of Plastics in Airplane Design and Construction," by Lawrence Ottinger, U. S. Plywood Corporation

Waterbury Section Holds Interesting Meeting

At the Jan. 15 meeting of Waterbury Section, Richard A. North, Farrel-Birmingham Co., in a paper on "Yankee Ingenuity Versus Modern Engineering," gave a history of American industry, tracing the industrial "firsts" from the discovery of glass and iron in colonial times up to the development of our present thorough engineering design and production methods. He was followed by Colonel James L. Walsh, chairman of the A.S.M.E. Committee on National Defense, who very ably and forcefully presented his conceptions of the present European conflict, its effect upon us, and the part which American engineers take in the National-Defense Program.

Edison Medal Awarded to George Ashley Campbell

The Edison Medal for 1940 has been awarded by the American Institute of Electrical Engineers to Dr. George Ashley Campbell, "in recognition of his distinction as scientist and inventor and for his outstanding original contributions to the theory and application of electric circuits and apparatus."

The Edison Medal was founded by associates and friends of Thomas A. Edison, and is awarded annually for "meritorious achievement in electrical science, electrical engineering, or the electrical arts" by a committee consisting of twenty-four members of the American Institute of Electrical Engineers.

The medal was presented to Dr. Campbell during the Winter Convention of the American Institute of Electrical Engineers held at the Bellevue-Stratford Hotel, Philadelphia, Pa., Jan. 27-31, 1941.

Junior Group Activities

Junior Group of Detroit Conducts Round-Table Discussion in December

WITH Dean Freund, University of Detroit, Professor Olmstead, secretary of Michigan Department of Registrations, and C. R. Alden, chief research engineer, Ex-Cell-O Corp., present at the meeting of Dec. 11, the Detroit Junior Group conducted a round-table discussion. Mr. Johnson proposed that engineering registration be in some way incorporated through the E.C.P.D., so that this matter of registration might be of some value to employers in selecting engineers. The guests and Juniors joined in the lively argument which attended this suggestion.

On Jan. 14, the guest speaker was Dr. E. J. Abbott, Physicists Research Corp., who spoke on "Noise Abatement in Industry." He discussed accuracy of the ear in remembering sound intensity and by means of his apparatus, talk, and slides, crystallized in the minds of those present a new and clearer understanding of the phenomenon of sound. He demonstrated how this method could be utilized in industry to reduce noise of machinery and other equipment.

Modern Precision Measurement Discussed Before Ontario Juniors

THE Ontario Junior Group was addressed on Jan. 23 by W. C. G. Fraser, of the Ontario Research Foundation, on the subject, "Modern Precision Measurement." He included in his talk a description of the various types of gages and standards, indicating the use of master, reference, and work gages, and discussed methods of testing their accuracy. Following the talk given in Hart House, the 50 Juniors and their friends visited the laboratories of the Ontario Research Foundation where they were afforded the opportunity of inspecting various precision measuring instruments.

Los Angeles Juniors Compete in Paper Contest for $25 Prize

THE Los Angeles Section has established an annual Junior Prize Award of $25 for the best paper by a Junior presented at either a Junior Group or Section meeting during the year. In order to give every Junior an opportunity to compete, the Los Angeles Junior Group has been sponsoring a series of meetings at which papers are presented by half a dozen Juniors. At the Feb. 3 session, 10-minute papers were presented by John Black, Robert Aaron, Joseph Spievak, J. Morris, D. Wiesley, and Ray Goodall.

Explosives and Aircraft Are Subjects of Philadelphia Junior Group Meetings

THE Philadelphia Junior Group continued its very active program when on Dec. 11 it heard Maynard M. Stevens of the Pennsylvania State Extension School give a demonstrated talk on "The Theory of Explosive Mixtures." Dr. Stevens has done much research work with explosive mixtures and is an authority in this field. He told about his findings on this subject and demonstrated explosions with various substances, some of which are not usually considered dangerous.

E. B. Wilford, president of the Pennsylvania Aircraft Syndicate, Ltd., spoke to the group at its meeting on Jan. 8. Mr. Wilford is co-inventor of the Wilford-Latta bomb-protection device and showed motion pictures of the tests on this new development. His main subject for the evening was, "The Future of Aircraft Design." He has been doing a great deal of development work on such types of airplanes as the gyroplane and the convertaplane and showed motion pictures of tests and flights of these planes. The speaker also outlined the advantages of "Beralite" on which he has been working with others. This alloy is a beryllium aluminum with a lower specific gravity than aluminum, strong as steel, and comparatively noncorrosive.

ONTARIO JUNIORS INSPECTING APPARATUS AT ONTARIO RESEARCH FOUNDATION FOLLOWING MEETING ON JAN. 23 AT WHICH W. C. G. FRASER, WHO IS FACING CAMERA, TALKED ON "MODERN PRECISION MEASUREMENT"

Metropolitan Junior Group Session on Engineering Errors

THE Metropolitan Junior Group held its regular monthly meeting in the Engineering Societies' Building on Jan. 28. The first portion of the meeting was devoted to the subject, "Engineering Errors and Their Control—A Symposium."

E. B. Hyde, Jr., connected with the mechanical-engineering department of the Consolidated Edison Company of New York, Inc., discussed the problem of errors in design and manufacture, citing actual examples with their corrections.

Dr. Walter A. Shewhart, associated with the Bell Telephone Laboratories, presented a short talk on the theoretical treatment of errors and the application of statistical control in mass production. Dr. Shewhart's talk was illustrated with slides.

Following an open discussion the motion picture, "The Failure of the Tacoma Suspension Bridge," was presented. A. E. Blirer, Stevens Institute of Technology, explained the size and construction of the bridge. The film was followed by a discussion led by Thomas C. Rathbone, Fidelity and Casualty Company of New York, who demonstrated a model showing the effect of wind on flexible structures. Mr. Rathbone also explained possible modes of vibration of the Tacoma Bridge and made several suggestions regarding methods of correction.

Chemists Sponsor Smokeless-Fuels Symposium

THE Gas and Fuel Division of the American Chemical Society is sponsoring a symposium on smokeless fuels and air-pollution abatement at its meeting in connection with the spring general meeting of the chemists in St. Louis, Mo., April 7 to 11.

The Division has received tentative promises of papers from a number of authorities on the subject of municipal smoke-abatement programs, low-temperature coal carbonization, smokeless solid fuels other than low-temperature coke, and on the position of gas in a program of smoke abatement.

With the Student Branches

St. Patrick, Patron Saint of Engineering, to Be Honored on March 17

Scores of Engineering Students to Make Merry at Parades, Exhibits, Dances, Smokers, and Gay Parties

A GREEN-letter day on the calendar of every mechanical-engineering student is March 17, because it honors the achievements of St. Patrick, the first far-famed mechanical engineer. History names him thus for his discovery of the Blarney stone whose use is indispensable in business and romantic affairs, as well as for his sponsoring of the first "worm drive." Sixty-one years ago The American Society of Mechanical Engineers honored him by adopting his insignia—the four-leaf clover—as a badge of membership and many a famous engineer has attributed his success to this lucky little talisman.

History of Celebration

The origin of the celebration of St. Patrick's Day by mechanical-engineering students, as traced by Prof. Walter Rautenstrauch of Columbia University and Prof. F. G. Hechler, of The Pennsylvania State College, dates back to the afternoon of March 16, 1902, and the graduating class of the Univeristy of Missouri, including besides Professor Rautenstrauch, George Morehead, vice-president, Link-Belt Co., John Brundage, Electric Bond and Share Co., Guy A. Robertson, chief engineer, Atlantic Coal & Ice Co., and Prof. Earl B. Smith, College of the City of New York.

Spring comes early in Missouri and by mid-March the grass is a sweep of lush green and the days long and lazy. In 1902, there was no break in the college calendar from Christmas to June, and Walter (the student) sweltering over a drafting board one warm afternoon, suggested the tedium be lessened by honoring St. Patrick on the morrow and broadcasting his engineering achievements to the world. In Professor Rautenstrauch's own words, "classes were cut the next day and various sorts of devilment were engaged in an unorganized fashion. We had girl friends and they were persuaded to cut class, perhaps I should say invited, and an inspection of green woods, the color appropriate to the occasion, was made."

The occasion was a walkout for the day, except in a few cases where the faculty, including Prof. Arthur M. Greene, now dean emeritus of engineering at Princeton University, took too decided a stand against the procedure. Two years later, in 1904, the first posters announcing a holiday on March 17 appeared at the University in Columbia and at the School of Mines at Rolla. But not until 1905 was the celebration of St. Patrick, patron saint of mechanical engineers, well organized with parades, open house, bands, dinners, etc., as well as the ceremony of knighting senior engineers by one of their members acting the part of St. Patrick. Before Dean Greene left Missouri in 1906, he was a convert to the idea, and appreciated the celebration for its consolidating of the entire student body in the school of engineering. So wholeheartedly did he lend his support, that he was made an honorary knight. From Missouri the custom traveled to neighboring colleges.

Minnesota in 1903

One bright morning, March 17, students on the campus of Minnesota University tripped over a huge stone bearing the inscription "Erin go brath," which means, in our language, "St. Patrick was a Mechanical Engineer." Some seniors concluded this was a message from the jolly saint himself and, with due reverence, dedicated the day to St. Patrick, as the patron saint of mechanical engineers.

1910 marked the turning point for St. Patrick's Day activities at Minnesota. Until then, the only means of celebration was the annual All-Engineering dance. The plan of activities since then, devised under the sponsorship of Prof. Geo. C. Preester, includes a parade, open house, brawl, and dance. In 1938, the celebration was moved to May for chances of better weather.

At Oklahoma

Since many schools are interested in celebrating St. Patrick's Day, the following program from the University is herewith reproduced:

March 9: Election of St. Patrick and Queen. St. Patrick is selected from five candidates by secret ballot. Only members of the Engineers' Club, composed of students from all branches, are allowed to vote. The queen is elected in similar fashion. Names of winners are announced on March 17 amid the splendor of the annual Engineers' Ball.

March 16: Engineers' stage show. A local talent show, held at a near-by theater, defrays the expenses of the celebration.

March 17: Engineers' Ball, coronation, fireworks. Halfway through the dance, the hall is hushed and the identity of St. Patrick revealed. He then crowns the queen. Following the ball, the "Loyal Knights of Old Trusty" fire "Old Trusty," an ancient cannon, in honor of St. Patrick's Day, following the fireworks display.

March 18: Open House and Banquet. The entire college of engineering jointly presents Open House, beginning with the engineers' parade across the campus, continuing with St. Patrick and the queen officially starting Open House at 10 a.m. From then until 10 p.m. the public views numerous exhibits prepared by the students and Southwest companies showing the latest developments in engineering equipment. In 1940 more than 10,000 attended Open House.

In the evening, all students, faculty, and practicing engineers from the Southwest attend the Engineers' Banquet to bid St. Patrick farewell. The queen concludes the memorable evening by dubbing those lucky ones Knights of St. Patrick.

The Whole Nation

In addition to those already mentioned the following honor St. Patrick as well: University of Alabama, University of Illinois, Rose Polytechnic Institute, Villanova University, New York University, and all the rest of the engineering schools in the New York metropolitan area. It is hoped by all engineers that the custom of doing homage to St. Patrick may spread so far that the President of the United States will declare a national holiday to honor St. Patrick, the first mechanical engineer.

Branch Meetings

British Columbia Carries On

THE secretary of British Columbia Branch, G. S. Wade, in reporting the Jan. 18 meeting, said, "The speaker was W. J. Nichols, who gave an excellent address on 'Plant Management.' There was no business." Even though their country is at war and many members have already answered the call to the colors, Canadian student members are carrying on in the best traditions of the profession.

Bucknell Branch at its meeting of Jan. 17 had P. J. Reeves, Timken Roller Bearing Company, give a talk on the latest developments in tapered roller bearings. The paper was illustrated with slides and motion pictures.

California Branch started off its meeting of Dec. 5 with singing school songs and eating a delicious chicken dinner. Following this, Prof. L. M. K. Boelter acquainted the members with the numerous problems that will confront them upon seeking employment.

Case Branch devoted its meeting of Jan. 8 to business. Among the things discussed were the joint meeting with the A.S.M.E. Cleveland Section, a dance, a speaking contest, the talk by Maxwell C. Maxwell at the next meeting, and plans for renewing the membership drive.

C.C.N.Y. Branch held the last meeting of the semester on Jan. 9. New officers for the coming semester were elected.

Crowded Colorado Meeting

There was such a fine turnout for the Jan. 8 meeting of Colorado Branch, 46 members and guests, that the session was late in starting. After Chairman Rosenkrans had welcomed the guests, a motion picture on the manufacture of automobiles was shown. With 41 present on

A.S.M.E. STUDENT MEMBERS AT UNIVERSITY OF MISSOURI

Jan. 22, R. F. Throne, Public Service Company, talked on "Log Sheets and Their Importance."

DREXEL BRANCH had an audience of 89 members and guests at the Jan. 9 meeting. P. J. Reeves, Timken Roller Bearing Company, gave a talk on "The Design, Fabrication, and Application of Tapered Roller Bearings." Slides were used to illustrate the paper. A motion picture, "The Slippage of Locomotive Driving Axles," followed.

GEORGE WASHINGTON BRANCH held a joint meeting with the A.S.C.E. and A.I.E.E. chapters. David Cushman Coyle, engineer and economist, gave a talk on "The Economics of Capitalism."

IOWA STATE COLLEGE BRANCH met on Jan. 8 and saw a motion picture depicting the story of the manufacture of wrought iron by the Byers process which involves the controlled addition of the necessary slag.

Fifty at Johns Hopkins Meeting

Fifty members and guests, the largest audience for any meeting this school year, attended the Jan. 8 meeting of JOHNS HOPKINS BRANCH. R. P. Kroon, manager of the research department in Philadelphia of the Westinghouse Electric & Manufacturing Co., gave a very interesting talk, illustrated with lantern slides, on turbine-design problems, including thrust, thermal expansion, and vibration.

KANSAS BRANCH in conjunction with the other engineering groups on the campus held a joint banquet on Jan. 12. Three hundred people were present. The principal speaker was W. O. Skousen, an F.B.I. agent, who gave a case history of a criminal and discussed the activities of the F.B.I. in tracing down criminals. Entertainment included a student negro quartet, an engineers' dance band, and group singing.

KENTUCKY BRANCH at the meeting of Jan. 10 presented as guest speaker Dr. J. D. Reichard, head of the U. S. Public Health Service Hospital located in Lexington, Ky. His paper was "The Nature and Treatment of Drug Addiction." On Jan. 17, Dr. Eduardo Hernandez described the life and ways of his country, Cuba.

Student Speakers at Louisville

On Jan. 9, LOUISVILLE BRANCH presented papers by Robert Burns, Richard Eckles, and Dillon Mapother. Following the talks there was a short discussion on the proposed trip to Atlanta, Ga.

MARQUETTE BRANCH at the meeting of Jan. 16 had as speaker, R. Ruebner, Delta Oil Co. He discussed "Greases, Their Manufacture and Application."

MICHIGAN BRANCH had an audience of 55 at the meeting of Jan. 22. Maxwell C. Maxwell, Yale & Towne Mfg. Co., was the guest speaker. His paper's title was "Materials Handling."

MINNESOTA BRANCH welcomed the new head of the mechanical-engineering department, Prof. Frank B. Rowley, at the Jan. 23 meeting. He gave a short talk on departmental plans and new building appropriations.

Flu Epidemic at Missouri

Due to a flu epidemic on the campus, MISSOURI BRANCH was requested by the University authorities to call off all meetings for several weeks. Already the student members are looking forward to the time when meetings can be resumed.

MONTANA STATE BRANCH received a gift of a gavel from the guest speaker at the Jan. 9 meeting. The speaker, Earl Sutherland, who is a graduate of the school, spoke on "Aircraft Carriers for the Navy," based on his work. At the meeting of Jan. 23, Ed Conrad presented some timely information on the development of radial airplane engines. He was followed by Hal Simmons who demonstrated his "snowmobile," a contraption he built out of spare parts for the agricultural-engineering department for use in the mountains for snow surveys.

NEBRASKA BRANCH had the first student paper of the school year presented at the meeting of Jan. 8 by Jack Wagner. He talked on "Air-Force Expansion for National Defense" in which he told of the needs and plans for an enlarged American air fleet.

NEVADA BRANCH reports the best turnout for the Dec. 12 meeting at which Mr. Titus and Mr. Kelly presented a joint paper on lubrication.

Newark Meeting Draws 150

More than 150 members and guests of NEWARK COLLEGE BRANCH were present on Jan. 9 and heard a paper on "Superfinish" given by Wilbur J. Peets, chief engineer, Singer Manufacturing Co. Following his talk, a motion picture on the use of superfinishing at the Chrysler Corporation was shown.

NEW MEXICO STATE BRANCH members on Jan. 17 voted to have the Branch affiliated with the Rocky Mountain Group, which means that the members will attend the Group Conference at Golden, Colo.

N.Y.U. BRANCH (mechanical) held a speaking contest on Dec. 16 at which the first prize of $4 was awarded to Winifred Ruder, second prize of $3 to George Cohen, third prize of $2 to George Bartle, and fourth prize of $2 to Erwin Loewen. Judges for the contest were Prof. C. E. Gus and Prof. H. Labberton, who contributed the fourth prize for the contest.

N.Y.U. BRANCH (evening) received reports from various committee chairmen at the Jan. 15 session. It was announced that inspection trips would be made in the near future. Many members signified their intention of attending the annual spring dance of the evening session.

NORTH CAROLINA STATE BRANCH members numbering 50 met on Jan. 14 to discuss the program for the rest of the school year. Plans are being made for the Engineers' Fair in April and the senior inspection trip the first week in May.

Defense Courses at North Dakota

Since the spare time of most members is now being devoted to attending national-defense classes, the day and time of the meetings of the NORTH DAKOTA STATE BRANCH have had to be changed. The members at the Jan. 16 meeting also decided not to have the Branch picture in the school annual.

NORTHWESTERN BRANCH has had to take cognizance of the fact that with the engineering school becoming the Northwestern Technological Institute, the school period is being changed from the semester to the quarter year for upper classmen in order to permit them to spend their period in industry. Because of this, it was voted at the Jan. 17 meeting to have election of officers each quarter instead of each semester.

OHIO STATE BRANCH held a meeting on Jan. 24 attended by 106 members. After regular routine business, the guest speaker, M. M. Boring, General Electric Co., gave a talk on the organization and activities of his company as well as its personnel problems.

OKLAHOMA BRANCH featured a paper on "How Engineering Ideas Are Developed," at its Jan. 9 meeting. It was given by W. G. Green, president of Engineering Laboratories, Inc., Tulsa, Okla. He explained the "gamma ray" method of logging oil wells and its development.

Oregon State Holds Breakfast

Members of OREGON STATE BRANCH held their annual winter breakfast on Jan. 19 at the Corvallis Hotel. The guest speaker was alumnus Thomas E. Taylor, who has been active in the air-conditioning field in the Northwest. Of particular interest to the audience was his discussion of the problems encountered in installing air conditioning in the Memorial Union ballroom.

PENNSYLVANIA STATE BRANCH gave its mem-

(*A.S.M.E. News continued on page 252*)

New PRINCIPLE

EXTENDS FIELD OF

Power Drive Design

NOW CHAIN SPEEDS are zooming up to 6000 feet a minute—and higher! That's more than twice the limit that old time engineering theory allowed, and it makes possible many drives formerly beyond good practice.

With these higher chain speeds come greatly increased power transmitting capacity, more efficient operation, and lower drive cost!

This revolutionary power drive development was originated by Morse engineers, when they decided to test the long-accepted speed limits.

Larger sprockets were used, with more teeth. Smaller pitch and narrower chain was substituted. The motor r.p.m., however, was not changed. And tests showed that centrifugal force—formerly supposed to limit chain speeds—did not hinder but actually was beneficial and helpful to Morse silent chain's operation.

It was found that centrifugal force reacting against the sprocket teeth of a Morse drive reduces shock loading, stabilizes joint action and permits much higher working loads. Power flows with almost unbelievable smoothness and silence. And best of all, power transmitting capacity of the drives increases faster than the speed of the chain increases!

Since the original laboratory work was done, Morse High Speed silent chain drives have made possible many drives formerly not thought practical and have greatly extended the field for the use of chain drives.

Put Morse High Speed silent chain drives to work for you. Let the Morse engineers help you to design your drives, whether they are in the field where chain drives have long been accepted as the outstanding and satisfactory means of driving or whether they are in this new range of modern practice.

SILENT CHAINS ROLLER CHAINS FLEXIBLE COUPLINGS CLUTCHES

MORSE *positive* DRIVES

MORSE CHAIN COMPANY ITHACA N. Y. DIVISION BORG-WARNER CORP.

A.S.M.E. STUDENT BRANCH AT STATE COLLEGE OF WASHINGTON

bers a plastics session on Jan. 7. A. R. Rector, Bakelite Corporation, showed motion pictures of the plastics industry as well as various articles made of plastic materials.

PRATT INSTITUTE members learned the short cuts in using a slide rule from a paper given at the Jan. 13 meeting by Elmer Hertzler, a member of the faculty.

R. I. State Has Johnson Rifle Paper

Captain Melvin Johnson, inventor of the Johnson automatic rifle, gave a paper on his rifle before 40 members and 60 guests of RHODE ISLAND STATE BRANCH on Jan. 15. His talk was illustrated with colored motion pictures showing the operation of his rifle and the simplicity in loading.

RICE BRANCH made an inspection trip on Jan. 8 to the mine of the United Salt Co. at Hockley, Texas. First the 25 members inspected the screening mill and the rock crushers and then were lowered 1000 ft below the surface of the earth into the mine.

SANTA CLARA BRANCH on Jan. 16 heard a paper by Maynard Brown on the "Manufacture of Tin Cans," in which he described the modern high-speed methods used today in the industry.

Something New at South Dakota

Don Walin, secretary of SOUTH DAKOTA STATE BRANCH, reports that A.S.M.E. emblems in the form of shoulder patches can be ordered from the college bookstore. The members took a trip to Burma on Jan. 15 via Dennis Roosevelt's film taken in that country and shown in the college armory.

SOUTHERN METHODIST BRANCH showed the motion picture "Alloy Steels" at the Jan. 7 meeting. It was very interesting and is recommended to other Branches.

STANFORD BRANCH met at the home of Professor Jacobsen on the evening of Jan. 28. Preceding the election of officers, Ken Maguire gave a short review of the inspection trip made to the Western Pipe and Steel Co., and Bill Holmes presented a paper on plastics.

TEXAS A.&M. BRANCH put the conduct of its Jan. 9 meeting in the hands of the juniors. After the "ice was broken" with the showing of a cartoon talking film, W. E. Frost talked on "The Manufacture and Use of Tetraethyl Lead" L. C. Ellis discussed "Hydramatic and Hydrodynamic Drives" and H. M. Rollins described the development of "Sealed-Beam Headlights."

TEXAS TECH BRANCH acted as host at the meeting of the Engineering Society of Texas Tech held on Jan. 13. The program consisted of a discussion and a motion picture concerning the manufacture of wire rope.

Grinding Wheels at Tufts

Sound films were shown through the courtesy of the Norton Company on Jan. 16 before the TUFTS BRANCH. Illustrated were the process of manufacturing grinding wheels, method of inspecting and marking the wheels, and the many applications of the product in all types of industries.

WASHINGTON STATE COLLEGE BRANCH presented its retiring chairman, Howard Hunt, with a small gold gavel in appreciation of his excellent services during the last semester. After the installation of the new officers at the meeting of Jan. 23, the members joined with the A.S.C.E. in viewing a colored motion picture entitled "The Romance of the Water Supply of the City of Lewiston."

WASHINGTON BRANCH reports that its football team won the school championship for 1940. Furthermore, the members intend to do their best to win the Charles T. Main Award contest as well as the main prizes at the Group Conference this spring.

A.S.M.E. Local Sections

Coming Meetings

Akron-Canton. March 20. Dinner at 6:45 p.m., M. O'Niel's Tea Room, Akron, Ohio. At meeting later, subject: "Statistics as It Affects Mass Production," by W. A. Shewhart, Bell Telephone Co.

Anthracite-Lehigh Valley. March 28. Scranton Chamber of Commerce, Scranton, Pa., at 8:00 p.m. Subject: "Plastics: Yesterday-Today-Tomorrow," by S. Leon Kaye, head, Materials & Research, Consolidated Molded Products Co., Scranton, Pa. There will also be a showing of the recent film "The Magic of Modern Plastics," released by the magazine *Modern Plastics*.

Chicago. March 4. 36th floor classroom, Civic Opera Building, 7:30 p.m. Subject: "National Defense and the A.S.M.E."

Detroit. March 4. White Star Refinery, Trenton, 3:00 p.m., inspection of plant. Dinner at Dearborn Inn at 6:30 p.m. Meeting, technical session, main ballroom, Dearborn Inn., 7:45 p.m. Subject: "Houdry Gasoline-Refining Process," by C. R. Miller, consulting engineer, Socony-Vacuum Oil Co.

East Tennessee. March 6. S. & W. Cafeteria at 6:30 p.m. Subject: "New Forces Mold Engineering," by R. L. Sackett, dean emeritus of Pennsylvania State College, and assistant to the Secretary A.S.M.E.

New Haven. March 18. Mason Laboratory, Yale University, 8:00 p.m. Subject: "Modern Steam, Electric, and Diesel Locomotives and Their Welding Problems," by James Partington, manager, engineering department, American Locomotive Co.

Men and Positions Available

Send inquiries to New York Office of Engineering Societies Personnel Service, Inc.

29 W. 39th St. New York, N. Y. | **211 West Wacker Drive Chicago, Ill.** | **57 Post Street San Francisco, Calif.** | **Hotel Statler Detroit, Mich.**

MEN AVAILABLE[1]

PRODUCTION, TOOL, OR METHODS ENGINEER; SUPERVISOR, tool designer, chief draftsman, shop foreman, toolmaker. Planning production, operation sheets, rate setting, estimating. Standard costs, job-evaluation studies. Shop instructor. New Jersey, Long Island, Metropolitan area. Me-601.

MECHANICAL ENGINEER, 48, with 27 years of engineering and executive experience in steel, process, and heavy industries, primarily on plant work; fully qualified to discharge engineering or executive duties. N. Y. license. Me-602.

MECHANICAL DEVELOPMENT ENGINEER, 33, married. M.E. degree, presently employed responsible position. Many creative contributions include nationally marketed products and patents; possesses compatible aptitudes, engineering practicability, and aesthetic design, tactfully forceful, cooperative. Me-603.

GRADUATE ENGINEER, M.I.T., 37, registered professional engineer, having 16 years of technical experience in modern central-station operation. Desires responsible position in operating or power-equipment manufacturing field. Now employed. Me-604.

MECHANICAL ENGINEER with 20 years' experience in design and charge of engineering department. Familiar with Diesel engines and marine steam engines for commercial and Navy work with sufficient shop experience to supervise work and testing of machinery. Me-605.

MATERIALS HANDLING ENGINEER AND PLANT

(*A.S.M.E. News continued on page 254*)

[1] All men listed hold some form of A.S.M.E. membership.

DESIGNER, professional license. Twenty-five year's experience in design and construction of materials-handling installations, industrial and chemical plants, and special plant equipment. Me-606.

MECHANICAL-INDUSTRIAL ENGINEER, 48, American, technically educated, broad diversified experience, excellent record of accomplishments. In present position as chief engineer of large industrial organization, over nine years. Desires change. Me-607.

PRODUCTION ENGINEER, B.S.M.E., 23, single, experienced in cost analysis, scheduling, and production work in large shipbuilding plant. Now employed. Would like connection with shipbuilding or airplane plant. Me-608.

CERTIFIED PUBLIC ACCOUNTANT, New York; industrial engineer; 33. Last ten years controller large manufacturing company. Capable executive. Standard costs, budgets, factory and office systems, time studies, taxes. Me-609.

MECHANICAL ENGINEER, 24, B.S. 1939, air conditioning and refrigeration major. Desires opportunity for experience leading to responsible position in mechanical-engineering field. Now employed. Available on two weeks' notice. Me-610.

E.E., M.E., married; 27 years' design, construction powerhouses, substations, distribution systems, industrial plants, executive engineering department large utility; purchasing engineering equipment foreign interest. English, German, Russian, and oriental languages. Me-611.

MECHANICAL ENGINEER, 22, single, B.S. 1940. Machine-shop experience. Interested in tool and die design or sales engineering. Willing to locate anywhere in United States. Me-612.

GRADUATE ENGINEER, 39, fifteen years' of electromechanical machine design, industrial-plant layout, design, and supervision of construction of production equipment, heating, ventilating, refrigerating, air conditioning, electric power. Metropolitan New York preferred. Me-613.

POSITIONS AVAILABLE

PRODUCTION ENGINEER, graduate, with experience in production and assembly of small motors, electric clocks, or electrical apparatus and who is capable of taking over company's present production from an engineering standpoint. Must be thoroughly acquainted with power presses, screw machines, gear-cutting machines, foot-press and power-press assembly work, and must have an understanding of the operation of electric motors, time-delay relays, timers, time switches, etc. Must also have thorough knowledge of manufacture of small instrument gears. Salary, $3600–$5000 a year. New England. Y-7285.

JUNIOR SALES ENGINEERS, recent graduate mechanical, chemical, or electrical, for engineering-sales divisions of prominent industrial organization. Permanent positions with excellent opportunities. Apply by letter giving full details of education, personal data, and experience, if any. East. Y-7289.

INDUSTRIAL ENGINEER, 28–45, to head time-study department of plant manufacturing precision instruments. Must be capable of working up standard data on machine-shop operations to eliminate individual job studies. Must have considerable experience on chart work. Salary, $45–$75 week. New England. Y-7317.

INDUSTRIAL ENGINEERS with five years of responsible work involving time study, methods, costs, and processing, preferably in metals trades. Position offers opportunity for future developments. South. Y-7331.

RESEARCH AND DEVELOPMENT ENGINEER, textile, 30–35, with experience in textile-fabric construction, i.e., one who can combine the different fibers such as rayon, cotton, etc. $250–$300 a month. Middle West, Y-7333-D.

DESIGNER AND DEVELOPMENT ENGINEER experienced with textile weaving and winding machinery. Should have such experience with textile-machinery manufacturing company, possibly having sold such machinery, thus having knowledge of problems confronted. Salary, $300 month. Middle West. Y-7334-D.

MACHINE DESIGNER AND DRAFTSMAN with all-round machine-design experience and, particularly, in the design of all kinds of wool machinery. Salary, $250–$300 a month. Middle West. Y-7335-D.

MECHANICAL ENGINEERS, 28–35, graduates of leading technical schools in United States. Require men well qualified to consult with industrial executives on modern production methods and plant improvements; must be at least 5 ft 10 in. and preferably taller, have good clean-cut appearance, and be capable of justifying a salary of from $5000 to $8000 annually. New York, N. Y. Y-7347.

GRADUATE MECHANICAL OR CHEMICAL ENGINEER, 35–45, to head engineering department of large and progressive chemical firm; will have charge of maintenance of all plants and buildings even to power production. Man should have experience in use of production machinery; should have proved executive ability yet be cooperative and able to get along with men in other departments; should have research approach to problems of company. Must have initiative, farsightedness, and ability to schedule operations. Salary open. Middle West. Y-7354-D.

TOOL DESIGNER AND PRODUCTION ENGINEER who is capable of accepting this responsibility for large plant and who has had at least 5 to 10 years' experience on this work, preferably in automotive or engine field. Salary, $400–$500 a month. Pennsylvania. Y-7357.

MECHANICAL OR INDUSTRIAL ENGINEER with some previous experience in conducting foremen's training courses. Must be particularly skilled in leading discussion. Should have some production or industrial background, preferably in machine-shop practice. Salary, $250–$300 a month. Pennsylvania. Y-7358.

WELDING ENGINEER with thorough background and experience in design of welded machine construction and actual shop-construction problems on this specialized type of work. Up to $500 a month. Pennsylvania. Y-7360.

SUPERINTENDENT OR CHIEF ENGINEER to take charge of operation of oil-gas plant. Previous experience in manufactured-gas plant necessary. Salary, $300–$350 a month. Central America. Y-7361.

TIME-STUDY ENGINEER, 30–40, with 3 to 5 years' experience on wage-incentive installation; 2 years' experience on machine-tool rate setting; some experience on rate simplification, job analysis, manufacturing methods, plant layout, and detailed job specifications. Some experience in recommending machine tools helpful. New England. Y-7364.

MECHANICAL ENGINEER, 37–45, who has varied industrial experience and who has held position of responsibility directing the engineering of process industry. Will be required to take charge of design, maintenance, and some operation of large plant. Must be thoroughly acquainted with power plants, chemical-plant piping, and machinery. Salary, $6000–$7000 year. New Jersey. Y-7384.

MECHANICAL SUPERINTENDENT, graduate engineer, with necessary background to supervise mechanical work of a 1000-man plant operating large foundry, sheet-metal, and wire-forming business. Would be responsible for operation of power-plant generating own power; maintenance of all types of power presses, wire-forming and automatic machines; heat, light, and power distribution; building maintenance supervision with all but minor repairs done by outside contractors. Opportunity. East. Y-7391.

PLANT ENGINEER, graduate of recognized engineering school, who has textile experience; some knitting experience is also desirable but not essential. Will be primarily responsible for supervision of operation of power plant consisting of two boilers, steam engine, and couple of Diesels. Will also have to direct maintenance crew in installation, repair, and maintenance of plant and equipment. Require man who would grow into organization and be responsible for recommendations to improve methods and machinery and assist in the establishment of standards and possibly of personnel department. $60 week. New England. Y-7405.

CHIEF INDUSTRIAL ENGINEER familiar with modern conveying systems for incoming and outgoing package goods. Should also be familiar with plant layout for efficient machine operation. Salary, $7000–$8000 a year. Y-7426-C.

SENIOR INDUSTRIAL ENGINEER, 30–35, graduate mechanical, from school of recognized standing. Should have 4 to 5 years' experience in industrial-engineering field, preferably, in diversified industry. Will represent company in field. Salary, $300 month, for training period; $500 month later. Headquarters, New York, N. Y. Y-7445.

PROCESS ENGINEER, graduate mechanical, with several years' experience with small electrical or machined parts for manufacturer of electric household appliances. Salary, $4000–$6500 year. New York State. Y-7446.

ENGINEER conversant with modern electric steel-foundry operation and equipment. Engineering background essential; must also have definite and successful operating experience either in charge of operations or as assistant. New York State. Y-7452.

GENERAL FACTORY MANAGER, graduate mechanical engineer, thoroughly experienced in factory management and with practical knowledge of production and engineering; should be well grounded in processing, methods, production control and planning, purchasing, stores and material control, and budgetary control of factory operations. Must be free to travel.

(*A.S.M.E. News continued on page 256*)

Headquarters, New York, N. Y. Y-7490.

COST ACCOUNTANT with diversified and practical factory experience in cost findings, cost distribution, cost analysis, who has headed cost department. Should have practical knowledge of all phases of factory cost including job cost accounting, standard costs, and process costing; should also be experienced in budgetary control and projections. Knowledge of general accounting practices and experience in analysis of operating expenses and in projecting profit and loss statements desirable. Should be familiar with office procedures. Free to travel. Headquarters, New York, N. Y. Y-7491.

PROCESS ENGINEERS, mechanical, who have thorough working knowledge of all types of manufacturing operations and machinery, jigs, dies, and tools; who can measure machine speeds, determine machine capacities, and whose practical experience enables them to determine most efficacious and efficient way to handle production; should know steps to pursue and things to do in each of steps. Free to travel. Headquarters, New York City. Y-7492.

Candidates for Membership and Transfer in the A.S.M.E.

THE application of each of the candidates listed below is to be voted on after March 25, 1941, provided no objection thereto is made before that date, and provided satisfactory replies have been received from the required number of references. Any member who has either comments or objections should write to the secretary of The American Society of Mechanical Engineers immediately.

KEY TO ABBREVIATIONS

Re = Re-election; Rt = Reinstatement; Rt & T = Reinstatement and transfer to Member

NEW APPLICATIONS

For Member, Associate, or Junior

ABERNATHY, GEO. T., Hilton Village, Va.
ADAMS, ARTHUR S., Ithaca, N. Y.
ALLEN, HAROLD D., Glen Rock, N. J.
BARLOW, DEWITT D., JR., Plainfield, N. J. (Re)
BELCHER, WALLACE E., JR. Philadelphia, Pa.
BORDT, FREDK. J., Troy, N. Y.
BOWERS, FRANK J., Youngstown, Ohio
BRAVO, CARLOS L., Mayaguez, P. R.
BRILL, J. B., Indianapolis, Ind.
BROWN, CARL F., Baltimore, Md.
BROWN, MALCOLM N., Buffalo, N. Y.
BRUNS, R. S., Maywood, N. J.
BURNS, THOS., Glen Rock, N. J.
CANEY, F. WHEELER, Arlington, N. J.
CERNEA, ROLAND E., Philadelphia, Pa.
COTTRELL, ROBT. BOYD, SR., Chicago, Ill.
CULP, HERBERT P., Nahant, Mass.
DARLING, PHILIP E., Texas City, Texas
EDWARDS, FRANK W., Diablo Heights, C. Z.
FALKOVICH, O. C., Atlanta, Ga.
FEGEL, ARTHUR C., Fanwood, N. J.
GARDNER, G. MACLEAN, Carbondale, Pa.
GARDNER, K. C., Coreopolis Heights, Pa.
GENTINE, HOWARD I., Chicago, Ill.
GROSSER, WILFRED R., Brooklyn, N. Y.
HAMILL, SAML. M., Cincinnati, Ohio
HARVEY, JAMES E., Rochester, N. Y.
HEADLEY, LEWIS M., Ames, Iowa
HEMENWAY, HENRY H., New York, N. Y.
IBOLD, PETER A., Bridgeport, Conn.
ISHAM, HOMER L., Compton, Calif.
JANTSCH, EMIL, Youngstown, Ohio
JURAN, J. M., New York, N. Y.
KLINE, G. M., Bethesda, Md.
LATHAM, GEO. R., 3RD, Millville, N. J.
LETOURNEAU, R. G., Toccoa, Ga.
LEWIS, EARL R., JR., Hartford, Conn.
LOCKHART, HAROLD A., Chicago, Ill.
MAHAFFY, REID A., Worcester, Mass. (Re)
MANSFIELD, WM. M., McGill, Nev.
MCGEE, HUGH P., Reading, Mass.
MIRO, RUDOLPH M., Tampa, Fla.
MORVAY, A. A., Chicago, Ill.
MYKLESTAD, N. O., Chicago, Ill.
ODELL, MALCOLM J., Rockaway, N. J.
PAGE, HAROLD D., New York, N. Y.
PARKS, JOS. A., JR., Radburn, N. J.
PERRY, DAVID J., Ferguson, Mo.
RANDALL, R. D., Berkeley, Calif.
RICHARDSON, LAWRENCE, Cambridge, Mass.
RIENKS, GEO. W., JR., San Francisco, Calif.
RIPLEY, M. N., Long Island City, N. Y.
ROBERTSON, ROY C., Atlanta, Ga.
ROY, NEREUS H., New York, N. Y.
ROY, ROBERT H., Ruxton, Md. (Rt & T)
SAGSTETTER, W. H., Denver, Colo.
SAJKOWSKY, S. D., Batavia, N. Y.
SANDLAND, CLIFFORD M., San Marino, Calif.
SCHEFE, F. K., Gary, Ind.
SCHROEDER, W. C., College Park, Md.
SILVERMAN, HARRY THOS., Gary, Ind.
SMOOT, CHAS. H., Chicago, Ill.
STARK, ALBERT C., Sharon Hill, Pa.
STICKLE, HAROLD E., Needham, Mass.
STRICKLER, H. K., Erie, Pa. (Rt)
THOMPSON, NORMAN, Bryn Mawr, Pa.
TOMPKINS, HOWARD, New York, N. Y.
TROBERG, GEO. S., Manette, Wash.
TURNER, THOS. T., Fort Worth, Texas (Re)
UPALEKAR, V. R., Bombay, India
VERNON, HOMER M., Newport News, Va.
VERTREES, RODNEY A., Millbrae, Calif.
VOCE, JOHN D., Birmingham 23, England
WELLMAN, S. K., Cleveland Heights, Ohio
WEST, HENRY I., Raleigh, N. C. (Re)
WOODBURY, GLEN P., Mountain Lakes, N. J.
ZINK, ADELBERT H., Manhattan, Kan. (Re)

CHANGE OF GRADING

Transfers to Fellow

BIERBAUM, CHRISTOPHER H., Buffalo, N. Y.
VON PHUL, WM., New York, N. Y.

Transfers to Member

ALLEN, HUGH M., Maricopa, Calif.
ASHKINAZY, S. B., Brooklyn, N. Y.
BLACKBURN, ALFRED T., Cincinnati, Ohio
COOK, HOWARD L., Bethesda, Md.
DAASCH, FRANCIS J., Houston, Texas
DEHAMER, JANUS R., Kalamazoo, Mich.
EAST, F. G., Toronto, Ontario, Canada
HANSON, HAROLD F., Pittsburgh, Pa.
HILL, ALBERT J., Central Boca Chica, Dominican Republic
JENS, A. H., Chicago, Ill.
KAZUTOW, ALEX., New York, N. Y.
KISNER, ALBERT G., Philadelphia, Pa.
LEHNER, JOHN B., Mineola, N. Y.
MCLAUGHLIN, EDMUND F., Pleasantville, N. Y.
MANNEY, CHAS. J., Kenmore, N. Y.
MULLIGAN, PAUL B., Saddle River, N. J.
MULLIKIN, HARWOOD F., JR., New York, N. Y.
NORMAN, B. F., JR., Freeport, Texas
PETERSON, FRANK P., JR., Corpus Christi, Texas
RODENBAUGH, DONALD I., Zanesville, Ohio
RUIZ, ALBERT L., Scotia, N. Y.
SIKES, J. M., Augusta, Ga.
SKARBEK, HENRY F. J., Union, N. J.
STROUSE, BERNARD H., Ventnor City, N. J.
TEICHMANN, FREDK. K., New York, N. Y.
WHITE, JOHN R., Caracas, Venezuela
WILSON, RUSHEN A., Milwaukee, Wis.

Transfers from Student-member to Junior—12

A.S.M.E. Transactions for February, 1941

THE February, 1941, issue of the Transactions of the A.S.M.E. contains:

Hydraulic Couplings for Internal-Combustion-Engine Applications, by N. L. Alison, R. G. Olson, and R. M. Nelden

Effect of Variations in Atmospheric Conditions on Diesel-Engine Performance, by J. S. Doolittle

The Significance of Diesel-Exhaust-Gas Analysis, by J. C. Holtz and M. A. Elliott

Lateral Stiffness and Vibration in Engine Structures, by Russell Pyles

The Combustion-Gas Turbine, by J. T. Rettaliata

Relative "Engine Efficiencies" Realizable From Large Modern Steam-Turbine-Generator Units, by G. B. Warren and P. H. Knowlton

Experience With Metals at High Temperatures for Power Plants, by A. E. White and C. L. Clark

Notes on the Measurement of Cylinder Power of High-Speed Steam Passenger Locomotives—Apparatus and Methods, by L. K. Botteron

Train Acceleration and Braking, by R. C. Jones

Thermodynamic Properties of Vapors, by E. F. Leib

Necrology

THE deaths of the following members have recently been reported to the Society:

BURNS, A. L., January 14, 1941
BUTTERS, ROY W., January 1, 1941
CAMPBELL, CHARLES A., September 4, 1940
RATAICZAK, THOMAS F., October, 1940
SUMNER, ELIOT, January 29, 1941